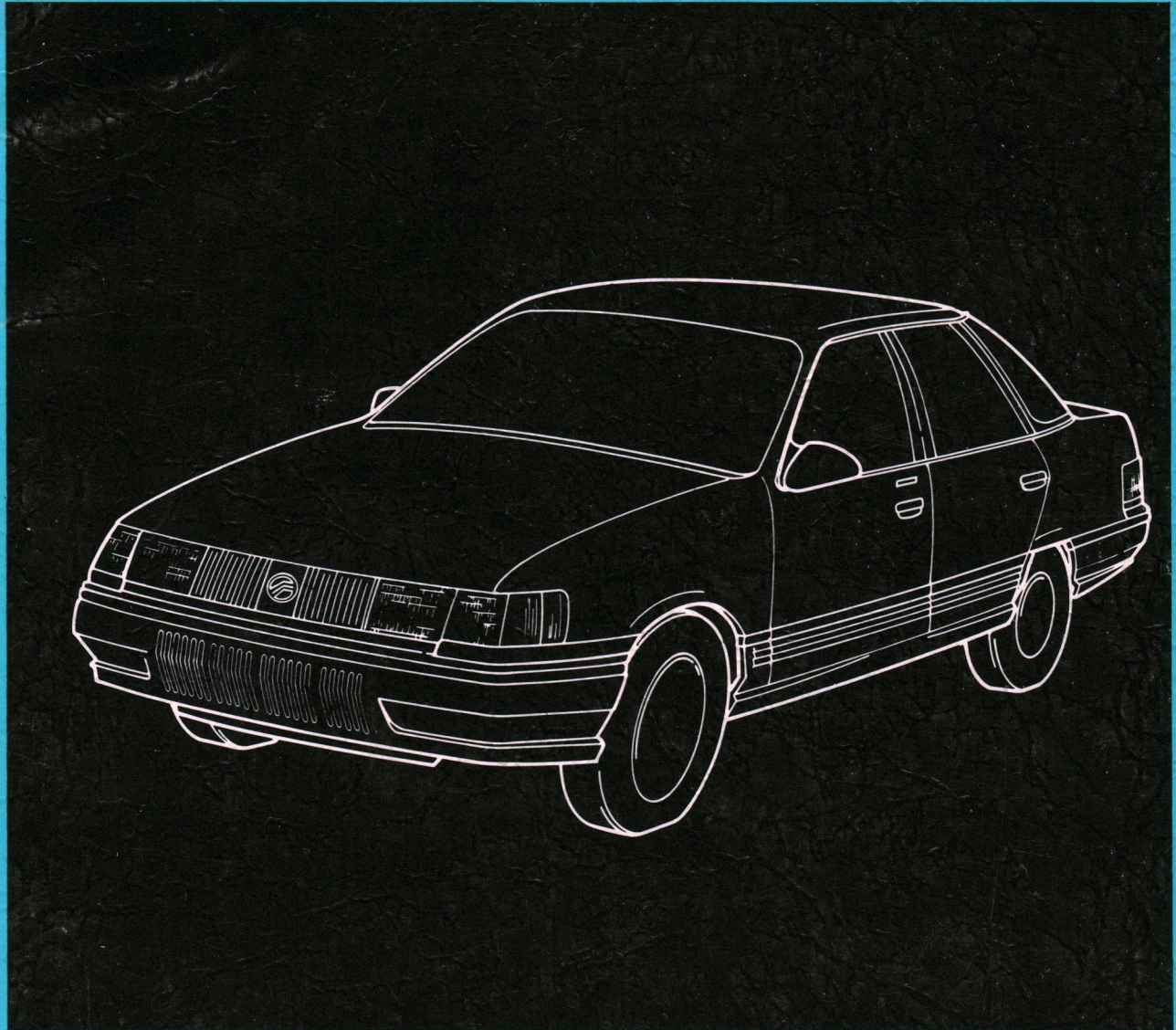


VIDEO REFERENCE BOOK

NON-EEC RELATED DRIVEABILITY DIAGNOSIS



Ford Parts and Service Division
Training and Publications Department

IMPORTANT SAFETY NOTICE

Appropriate service methods and proper repair procedures are essential for the safe, reliable operation of all motor vehicles, as well as for the personal safety of the individual doing the work. This video reference book provides general directions for accomplishing service and repair work with tested, effective techniques. Following them will help ensure reliability.

There are numerous variations in procedures, techniques, tools and parts for servicing vehicles, as well as in the skill of the individual doing the work. This video reference book cannot possibly anticipate all such variations and provide advice or cautions as to each. Accordingly, anyone who departs from instructions provided in this video reference book must first establish that he compromises neither his personal safety, nor the vehicle integrity by his choice of methods, tools or parts.

As you read through the procedures, you will come across **NOTES**, **CAUTIONS** and **WARNINGS**. Each one is there for a specific purpose. **NOTES** give you added information that will help you complete a particular procedure. **CAUTIONS** are given to prevent you from making an error that could damage the vehicle. **WARNINGS** remind you to be especially careful in those areas where carelessness can cause personal injury. The following list contains some general **WARNINGS** that you should follow when you work on a vehicle.

- Always wear safety glasses for eye protection.
- Use safety stands whenever a procedure requires you to be under the vehicle.
- Be sure that the ignition switch is always in the OFF position, unless otherwise required by the procedure.
- Set the parking brake when working on the vehicle. The manual transmission shifter lever should be in REVERSE (engine OFF) or NEUTRAL (engine ON) unless instructed otherwise for a specific service operation.
- Operate the engine only in a well-ventilated area to avoid the danger of carbon monoxide.
- Keep yourself and your clothing away from moving parts when the engine is running, especially the fan and belts.
- To prevent serious burns, avoid contact with hot metal parts such as the radiator, exhaust manifold, tail pipe and muffler.
- Do not smoke while working on the vehicle.
- To avoid injury, always remove rings, watches, loose hanging jewelry and loose clothing before beginning to work on a vehicle. Tie long hair securely behind your head.
- Keep hands and other objects clear of the radiator fan blades.

The recommendations and suggestions contained in this video reference book are made to assist the dealer in improving his dealership parts and/or service department operations. These recommendations and suggestions do not supersede or override the provisions of the Warranty and Policy Manual, and in any cases where there may be a conflict, the provisions of the Warranty and Policy Manual shall govern.

The descriptions, test procedures and specifications in this video reference book were in effect at the time the video reference book was approved for printing. Ford Motor Company reserves the right to discontinue models at any time, or change specifications, design, or testing procedures without notice and without incurring obligation. Any reference to brand names in this video reference book is intended merely as an example of the types of tools, lubricants, materials, etc. recommended for use. Equivalents, if available, may be used. The right is reserved to make changes at any time without notice.

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Driveability is one of the major service concerns in today's vehicles. Complex electronic engine control (EEC) and emission systems have made driveability diagnosis more difficult than ever. However, even though engine operation in most of today's vehicles is controlled by EEC systems, non-EEC related systems and components can still be the cause of driveability problems. This video reference book will provide the following information:

- Driveability terms and definitions
- Overview of the non-EEC related operation of these engine systems:
 - Vacuum
 - Ignition
 - Mechanical
 - Air Intake
 - Fuel
 - Emission
- Explanations of how some malfunctions can cause specific driveability symptoms
- Description of diagnosis procedures, including visual inspection, plus the use of test equipment and test procedures

DRIVEABILITY TERMS AND DEFINITIONS

Driveability, as related to engine performance, includes everything that the owner expects from a properly operating engine, such as easy starting (hot or cold engine), acceptable smoothness at

idle, good acceleration in all speed ranges, instant response, and full power. Driveability can also apply to how the transmission operates, the way the vehicle handles, and to owner expectations in regard to noise, vibration and harshness. For purposes of this program, the driveability concerns relate only to engine performance. The rest of the driveability terms consist of the various symptoms that can occur when the vehicle has a driveability problem.

The chart, Driveability Symptoms and Definitions (Fig. 1), gives the correct term to use for each symptom, the definition of the symptom and the engine systems that might cause the symptom. Notice how one engine system can cause many symptoms and, on the other hand, how most symptoms can have more than one system as their cause.

This chart presents driveability symptoms and their definitions as they are used in the Engine/Emissions Diagnosis Manual, Volume H. Since a customer may not use these terms to describe the problem with the vehicle, it is very important for the Service Writer to verify the complaint. To do this, the Service Writer should get as much information as possible from the customer and then road test the vehicle. The Service Writer can then relate the problem to the technician in the same terms that are used in the Engine/Emissions Diagnosis Manual, Volume H. That way, the technician will be sure to follow the correct diagnosis procedures to solve the driveability problem.

INTRODUCTION

TERM	DEFINITION	SYSTEM CAUSE*
CRANKS NORMALLY, BUT WON'T START	THE STARTER WILL CRANK THE ENGINE AT NORMAL SPEED, BUT THE ENGINE SHOWS NO INDICATION OF "FIRING" OR WILL NOT CONTINUE RUNNING WHEN THE KEY IS MOVED FROM THE START TO THE RUN POSITION.	① ③ ④ ⑥
STARTS NORMALLY, BUT WON'T RUN (STALLS)	THE STARTER WILL CRANK THE ENGINE AT NORMAL SPEED, THE ENGINE WILL START, BUT WILL NOT CONTINUE TO RUN.	① ② ④ ⑥
CRANKS NORMALLY, BUT SLOW TO START	THE STARTER WILL CRANK THE ENGINE AT NORMAL SPEED, BUT THE ENGINE REQUIRES EXCESSIVE CRANKING TIME BEFORE STARTING. NOTE: IF AN ENGINE WILL START, BUT WILL NOT STAY RUNNING WHEN THE KEY IS RETURNED TO THE ON POSITION, THE SYMPTOM "STARTS NORMALLY, BUT WON'T RUN (STALLS)" SHOULD BE USED.	① ② ③ ④ ⑤ ⑥
ROUGH IDLE	ENGINE VIBRATES EXCESSIVELY DURING IDLE.	① ② ③ ④ ⑥
MISSES UNDER LOAD	ONE OR MORE CYLINDERS DO NOT FIRE UNDER LOAD (ACCELERATION, CLIMBING HILLS, PULLING A TRAILER, ETC.). USUALLY ACCOMPANIED BY LACK OF POWER.	③ ④ ⑥
STALLS ON DECEL OR QUICK STOP	ENGINE STALLS WHEN DECELERATING OR DURING A QUICK STOP.	① ③ ⑥
HESITATES OR STALLS ON ACCELERATION	A LAG BETWEEN THE TIME THE THROTTLE IS DEPRESSED AND ACCELERATION BEGINS.	① ② ③ ④ ⑤ ⑥
BACKFIRES (INDUCTION OR EXHAUST)	ABNORMAL COMBUSTION IN THE INDUCTION OR EXHAUST SYSTEM, WHICH PRODUCES A LOUD NOISE.	① ② ③ ④ ⑥
LACK OF POWER	PERFORMANCE DOES NOT MEET DESIGN INTENT OR CUSTOMER EXPECTATIONS.	① ③ ④ ⑤ ⑥
SURGE AT STEADY SPEED	AN UNEXPECTED CHANGE IN ENGINE SPEED, WHICH USUALLY HAS A REPETITIVE PATTERN OR A REPETITIVE OCCURRENCE OF ONE OR MORE CYLINDERS NOT FIRING.	① ② ③ ④ ⑥

* Refer to "Key" at end of chart (next page)

Figure 1. Driveability Symptoms and Definitions

INTRODUCTION

TERM	DEFINITION	SYSTEM CAUSE*
ENGINE DIESELS (RUN ON)	ENGINE CONTINUES TO RUN AFTER THE KEY IS RETURNED TO THE OFF POSITION.	① ② ③
ENGINE NOISE	ANY UNUSUAL ENGINE NOISE.	① ② ③ ④ ⑤ ⑥
POOR FUEL ECONOMY	FUEL ECONOMY DOES NOT MEET DESIGN INTENT OR PUBLISHED INFORMATION.	① ③ ④ ⑤ ⑥
HIGH OIL CONSUMPTION	OIL CONSUMPTION, WHICH EXCEEDS ONE QUART PER 900 MILES AFTER BREAK-IN.	① ⑤ ⑥
SPARK KNOCK/PINGING	ABNORMAL COMBUSTION ACCOMPANIED BY AN AUDIBLE "PINGING" NOISE.	① ② ④ ⑤ ⑥
ENGINE VIBRATES AT NORMAL SPEEDS	DURING A STEADY CRUISE, THE ENGINE VIBRATES EXCESSIVELY	①
ENGINE RUNS COLD	AN ABNORMAL CONDITION UNDER WHICH THE COOLANT TEMPERATURE DOES NOT REACH OPERATING TEMPERATURE. SYMPTOMS INCLUDE POOR FUEL ECONOMY AND NO HEAT FROM THE VEHICLE'S HEATER.	①
ENGINE RUNS HOT	AN ABNORMAL CONDITION UNDER WHICH THE COOLANT TEMPERATURE BECOMES EXCESSIVE. SYMPTOMS INCLUDE TEMPERATURE WARNING LAMP COMING ON, TEMPERATURE GAUGE IN THE OVERHEAT RANGE, OR COOLANT OVERFLOWING THE OVERFLOW TANK.	① ② ④ ⑥
EXHAUST SMOKE	AN ABNORMAL CONDITION WHERE THE EXHAUST IS NOTICEABLE OR ANY UNUSUAL EXHAUST SMELL, SUCH AS ROTTEN EGGS (HYDROGEN SULFIDE).	① ③ ⑤ ⑥
GAS SMELL	ANY GASOLINE FUEL SMELL OR VISIBLE LEAKS.	③ ⑥
* ① Mechanical ② Vacuum ③ Fuel ④ Ignition ⑤ Air Intake ⑥ Emissions		

Figure 1. Driveability Symptoms and Definitions (Continued)

INTRODUCTION

ENGINE/EMISSIONS DIAGNOSIS MANUAL

The Engine/Emissions Diagnosis Manual, Volume H (Fig. 2) is one of the most important “tools” the technician uses. It helps the technician to determine what system, EEC or non-EEC, is at fault. If it is an EEC driveability concern, the manual will aid in diagnosing the driveability problem. Following the procedures in this manual will provide quicker, more effective diagnosis of driveability problems.

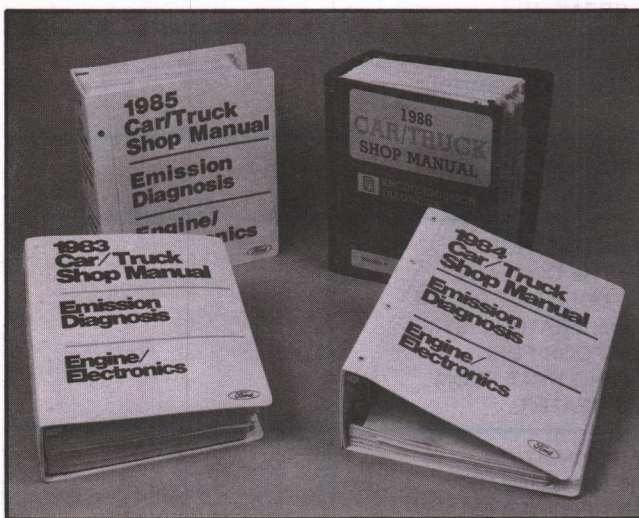


Figure 2. Engine/Emissions Diagnosis Manuals, Volume H

OBJECTIVES

Upon completion of this video training course, you will be able to:

- Define and describe the following terms:
 - Cranks normally, but won't start
 - Starts normally, but won't start
 - Starts normally, but won't run (stalls)
 - Rough idle
 - Misses under load
 - Stalls on deceleration or quick stop
 - Hesitates or stalls on acceleration
 - Backfires (induction or exhaust)
 - Lack of power
 - Surge at steady speed
 - Engine diesels (run on) or idles too fast
- Engine noise
- Poor fuel economy
- High oil consumption
- Spark knock/pinging
- Engine vibrates at normal speeds
- Engine runs cold
- Engine runs hot
- Exhaust smoke
- Gas smell
- Describe how two or three malfunctions in the following major engine systems can cause the driveability symptoms identified for that system:
 - Fuel
 - Air intake
 - Mechanical
 - Ignition
 - Vacuum
 - Emissions
- Identify all of the inspection points for the following major engine systems:
 - Fuel
 - Air intake
 - Mechanical
 - Ignition
 - Vacuum
 - Emissions
- Select the correct piece of test equipment to use for the following checks or tests to be made:
 - Fuel volume test (hose with Schrader valve, quart bottle with pint gradations)
 - Wet and dry compression checks (compression gauge)
 - Circuit continuity check (volt/ohmmeter)
 - Engine base timing check and set (timing light)
 - Spark plug wire check (spark tester)
 - Manifold vacuum test (vacuum gauge)
 - Fuel system pressure check (pressure gauge)
 - Emissions vacuum component checks (hand vacuum pump)
 - Circuit voltage and resistance checks (volt/ohmmeter)
 - Check plug firing (engine analyzer)
 - Check engine rpm (engine analyzer)
 - Exhaust gas composition check (engine analyzer)

- Demonstrate the ability to connect each of the following pieces of automotive test equipment to the vehicle so that it will give accurate readings:
 - Volt/ohmmeter
 - Timing light
 - Spark tester
 - Compression gauge
 - Vacuum gauge
 - Vacuum pump
 - Test light
 - Pressure gauge
- Perform the following tests and checks with the equipment stated:
 - Wet and dry compression checks (compression gauge)
 - Circuit continuity check (volt/ohmmeter)
 - Engine base timing check and set (timing light)
 - Check firing of ignition coil (12V test light)
 - Ignition coil wire check (spark tester)
 - Manifold vacuum test (vacuum gauge)
 - Fuel system flow and pressure test (pressure gauge, hose, calibrated liter/quart bottle)
 - Vacuum component check (hand vacuum pump)
 - Spark plug wire resistance check (volt/ohmmeter)
 - Check plug firing (engine analyzer)
 - Engine cranking test (engine analyzer)
 - Exhaust gas composition check (engine analyzer)
- Identify the readings that would appear on the equipment stated for a properly operating vehicle for the following tests and checks:
 - Wet and dry compression checks (compression gauge)
 - Circuit continuity check (volt/ohmmeter)
 - Engine base timing check and set (timing light)
 - Check firing of ignition coil (12V test light)
 - Ignition coil wire check (spark tester)
 - Manifold vacuum test (vacuum gauge)
 - Fuel system flow and pressure test (pressure gauge, hose, calibrated liter/quart bottle)
 - Vacuum component check (hand vacuum pump)
 - Spark plug wire resistance check (volt/ohmmeter)
 - Check plug firing (engine analyzer)
 - Engine cranking test (engine analyzer)
 - Exhaust gas composition check (engine analyzer)
- Perform the correct inspections, checks, and tests (as defined in the Engine/Emissions Diagnosis Manual) to diagnose and repair a sample, non-EEC related engine driveability symptom:
 - Given identification of the specific vehicle where the symptom is occurring
 - Given that the EEC system is not the source of the symptom
 - Given the Engine/Emissions Diagnosis Manual and any additional Shop Manuals needed for reference
 - Without taking any incorrect diagnosis steps

VACUUM SYSTEM

OPERATION

“Vacuum” is a pressure level that is lower than the earth’s atmospheric pressure at any given altitude. The higher the altitude, the lower the atmospheric pressure.

Vacuum in any four-stroke engine is created by the downward movement of the piston during the intake stroke. With the intake valve open and the piston moving downward, a partial vacuum is created within the cylinder and intake manifold (Fig. 3). The automotive engine creates a partial vacuum that is relatively continuous. In a typical 4-cylinder engine, one cylinder is always at some stage of the intake cycle. The amount of vacuum created is partially related to the positioning of the choke (on carbureted vehicles) and to the throttle plate(s). The throttle plate not only admits air or air/fuel into the intake manifold, it also helps to control the amount of vacuum available during engine operation. At closed throttle idle, the vacuum available is usually between 15–22 inches. At a wide-open throttle acceleration, the vacuum can drop to zero.

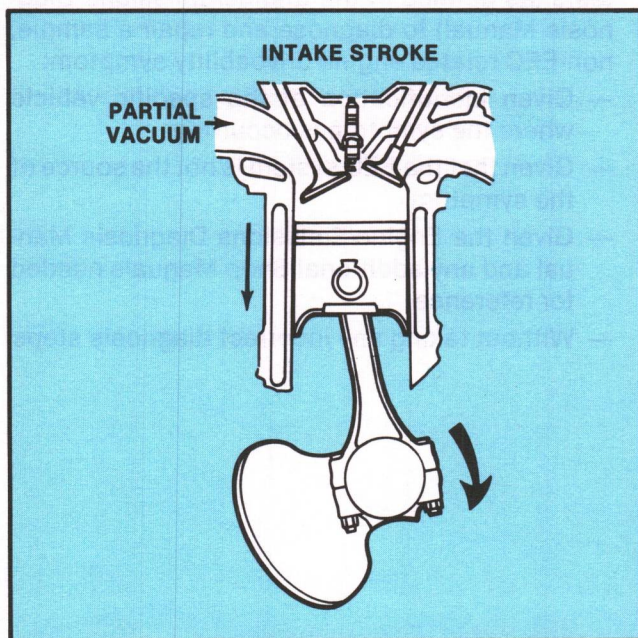


Figure 3. Creating Partial Vacuum

NOTE: A perfect vacuum would prevent the engine from running. If the engine were air tight, air and fuel would not be able to enter the engine for combustion.

ENGINE VACUUM

Engine vacuum is used for the following systems:

- **Air Intake System**—Vacuum is used to draw filtered air into the engine and to control vacuum-operated devices which, in turn, are used to control the temperature of the air allowed into the engine. This improves fuel vaporization so that fuel will burn more efficiently.
- **Fuel Induction System**—Certain vacuum-operated devices are added to carburetors and some central fuel-injected throttle bodies to ease engine start-up, warm-and-cold engine drive-away, and to compensate for an air conditioner load on the engine.
- **Emission Control System**—Most emission control output devices operate on vacuum. This vacuum is usually controlled by solenoids that are opened or closed, depending on electrical signals received from the electronic control assembly (ECA). Other systems use switches that are controlled by engine coolant temperature, such as a ported vacuum switch (PVS), or by ambient air such as a temperature vacuum switch (TVS).
- **Accessory Controls**—Engine vacuum is also used to control operation of certain accessories; such as air conditioner/heater systems, power brake boosters, air distribution doors, power brake boosters, speed-control components, automatic transmission vacuum modulators, etc.

An engine emissions vacuum schematic is located inside the engine compartment on all Ford vehicles. The following schematic shows the vacuum hose routings and vacuum source for all emissions-related equipment. The vacuum schematic illustrated is from the 3.0L engine used in the Taurus/Sable vehicles (Fig. 4). It is different from the computer-generated types that have been used over the previous years. This new type of schematic shows the relationship of the components as they are mounted on the engine.

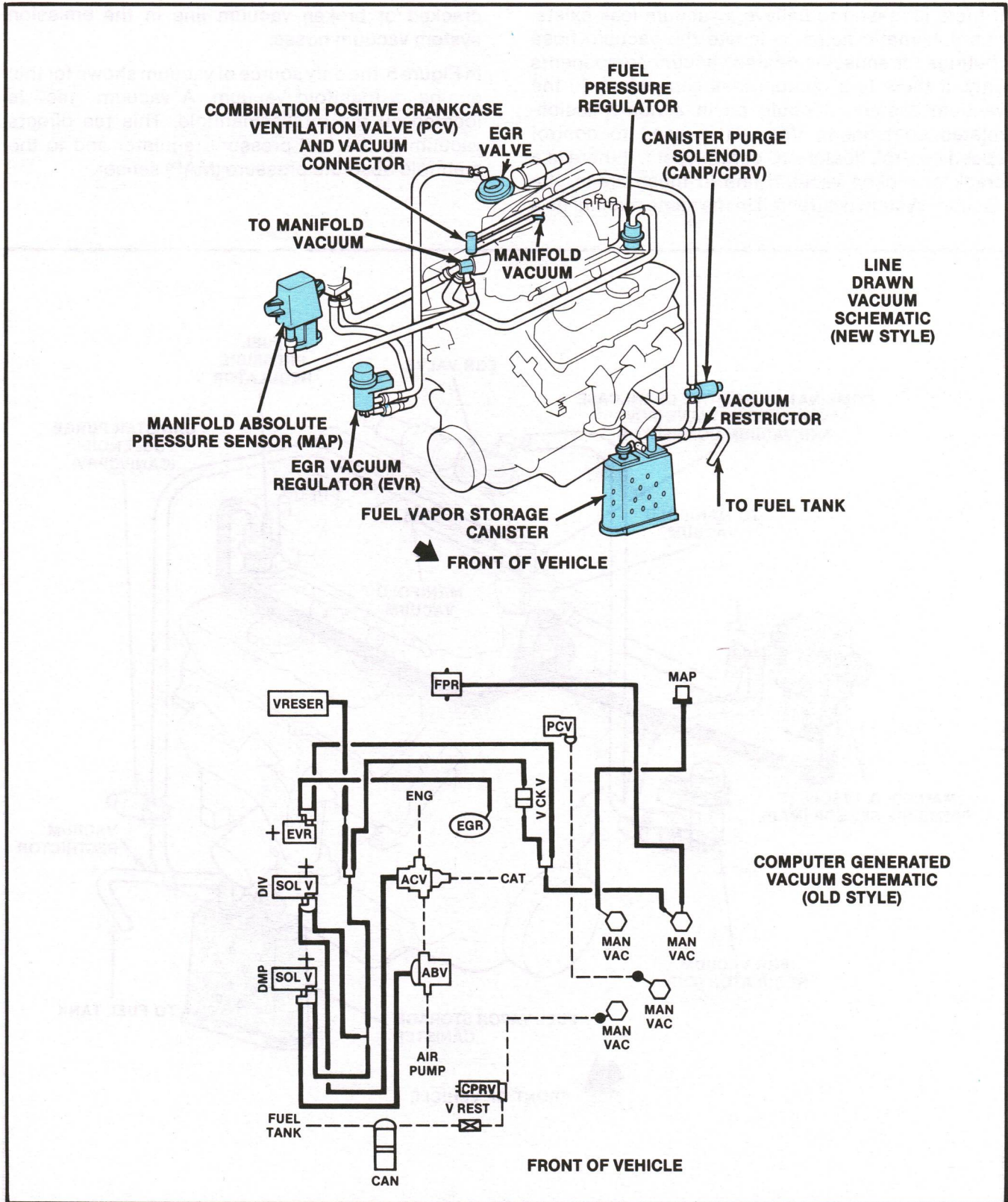


Figure 4. Engine Emissions Vacuum Schematics

VACUUM SYSTEM

If there is reason to believe a vacuum leak exists, this schematic helps to locate the vacuum hose routings for emission-related vacuum components only. If there is a vacuum leak somewhere in the vacuum system, it could be in a non-emission-related component. Vacuum is used to control speed control, heater-A/C controls, etc. If there is a crack or broken vacuum line in these areas, the vacuum system is affected in the same manner as a

cracked or broken vacuum line in the emission system vacuum hoses.

In Figure 5, the only source of vacuum shown for this engine is manifold vacuum. A vacuum "tee" is located on the intake manifold. This tee directs vacuum to the fuel pressure regulator and to the manifold absolute pressure (MAP) sensor.

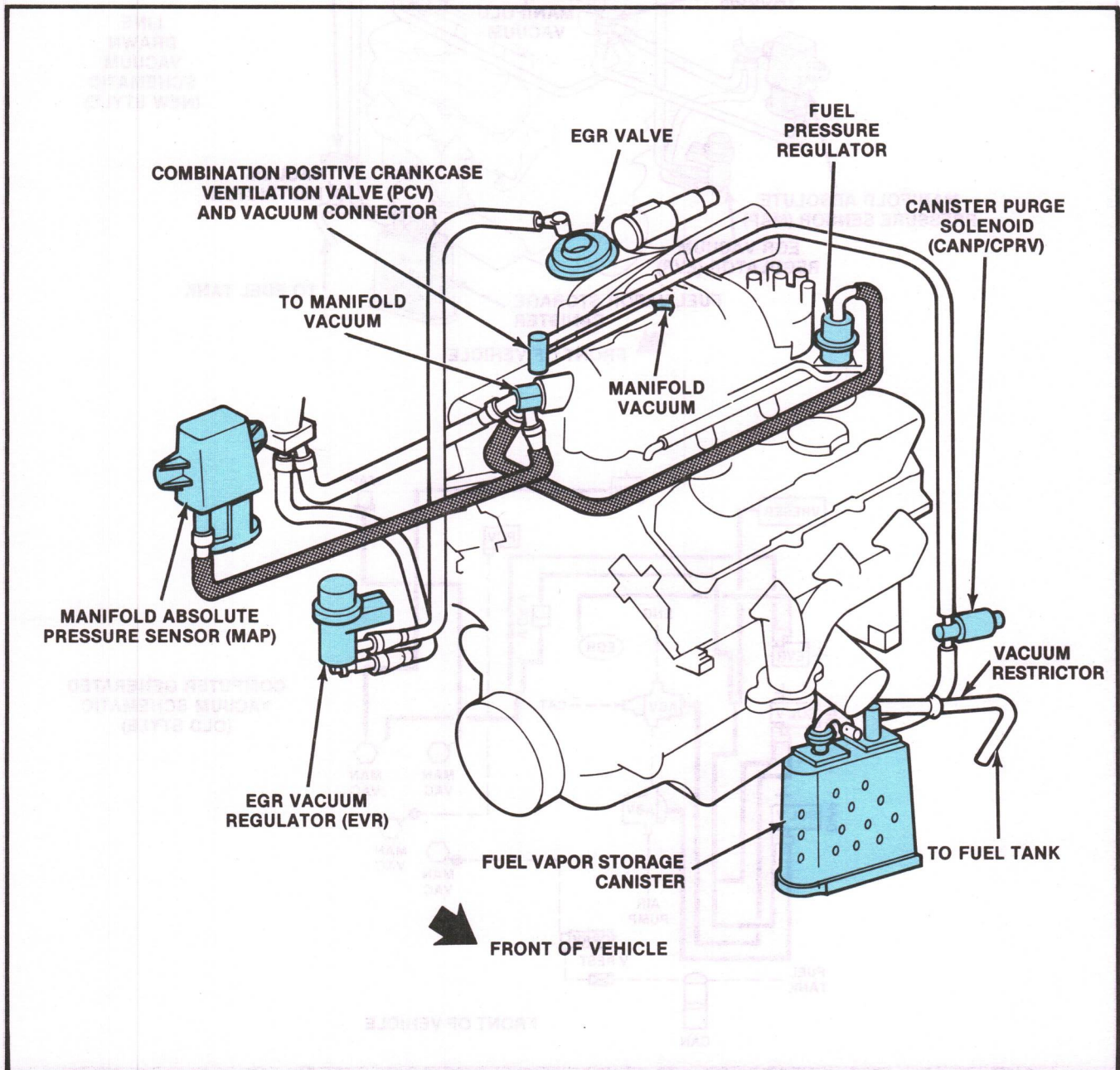


Figure 5. Fuel Pressure Regulator and MAP Sensor Vacuum

VACUUM SYSTEM

A vacuum fitting is located on the right rear of the dash panel next to the MAP sensor. This fitting directs vacuum to the EGR vacuum regulator (EVR) solenoid. The solenoid, when energized by the ECA,

allows vacuum to control the EGR valve located on the intake manifold (Fig. 6). This fitting receives vacuum from the intake manifold.

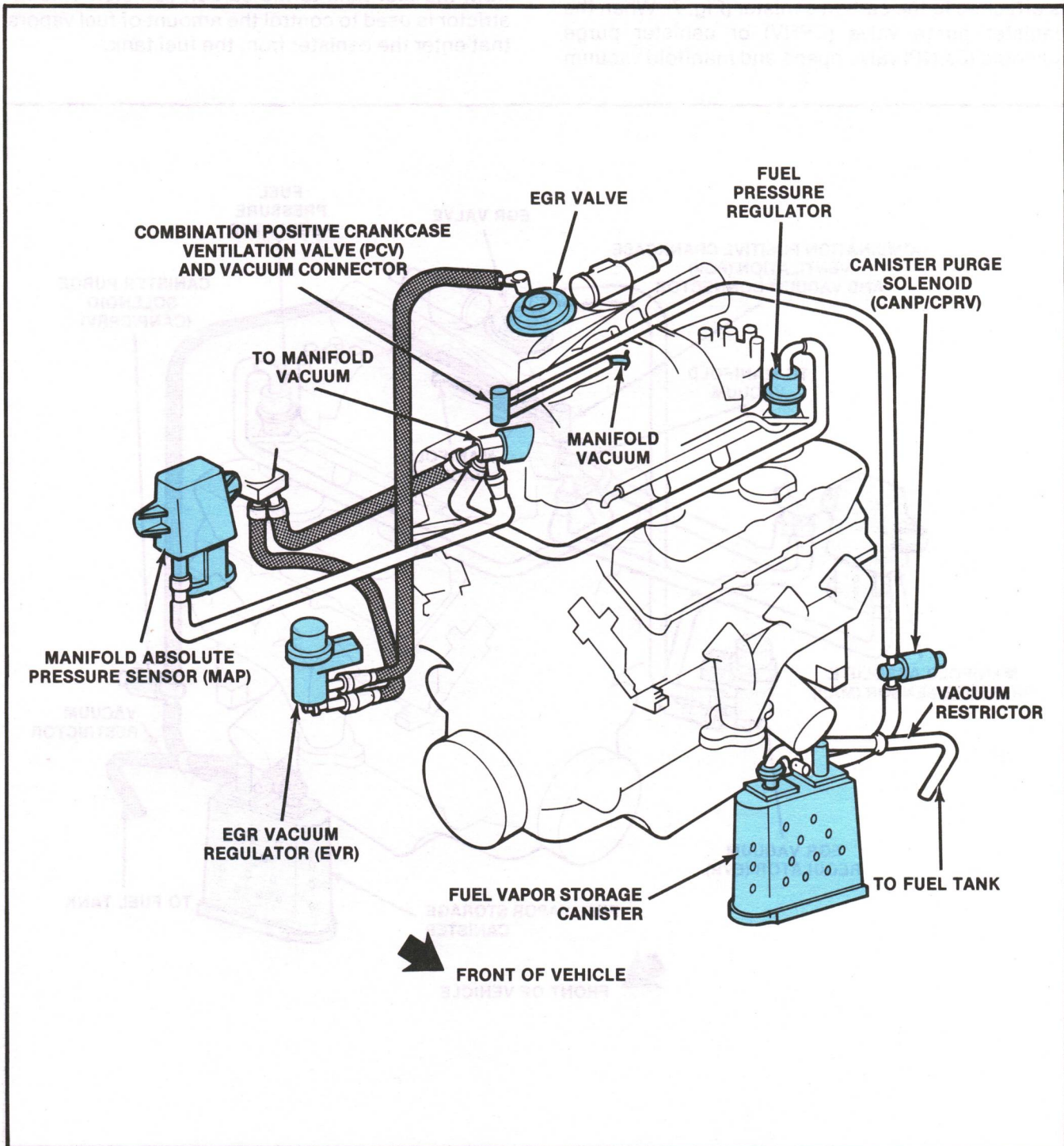


Figure 6. EGR Vacuum Flow

VACUUM SYSTEM

The positive crankcase ventilation (PCV) valve is also attached to a source of manifold vacuum. This vacuum draws in the blow-by vapors, with the amount of vapors allowed to flow controlled by the PCV valve. A vacuum fitting on top of the PCV valve, is attached to the carbon canister (Fig. 7). When the canister purge valve (CPRV) or canister purge solenoid (CANP) valve opens and manifold vacuum

is applied to the carbon canister, fuel vapors stored in the canister will be drawn into the intake manifold for combustion.

A vacuum restrictor (V REST) is located in the line from the fuel tank to the carbon canister. This restrictor is used to control the amount of fuel vapors that enter the canister from the fuel tank.

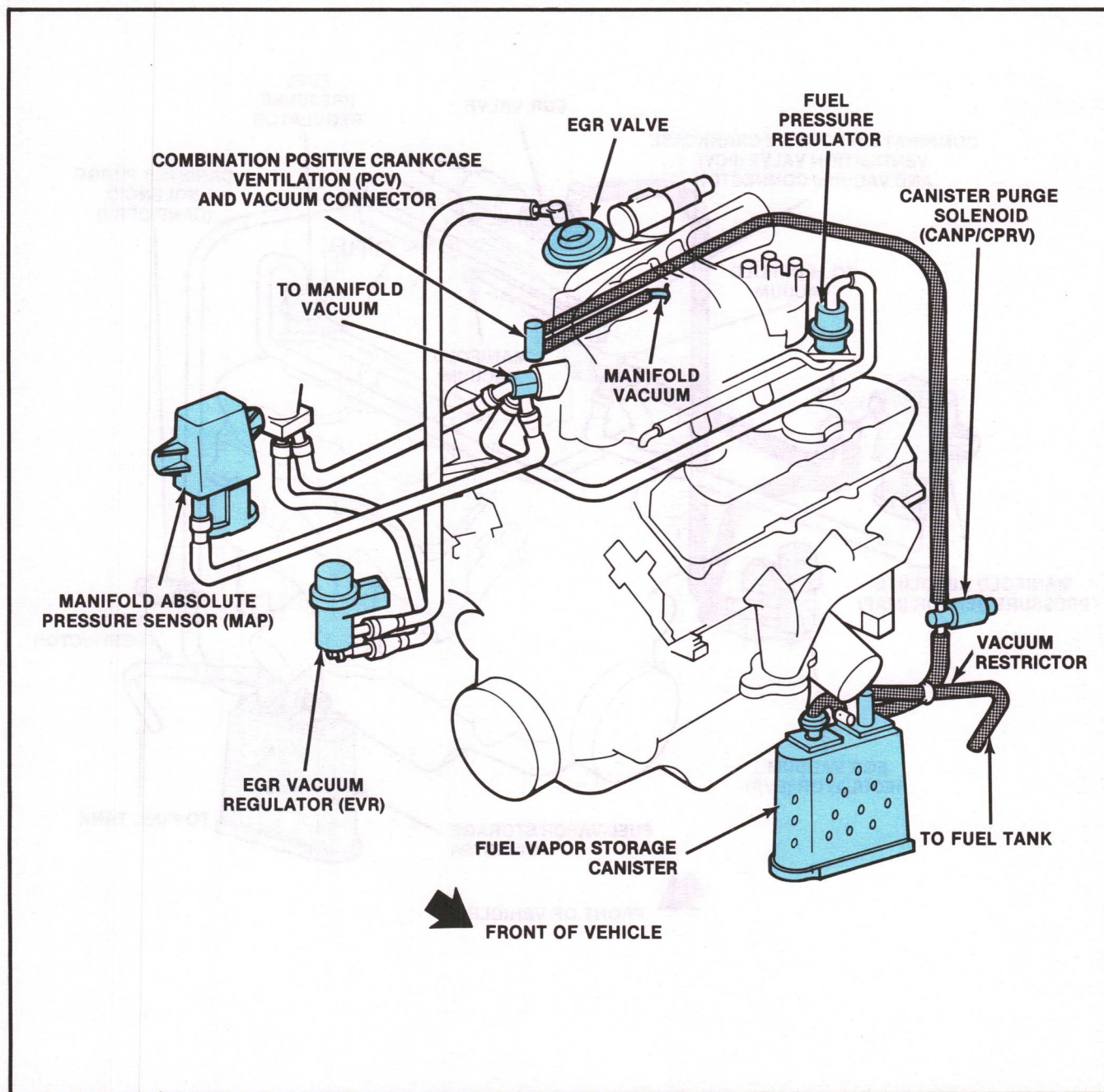


Figure 7. PCV and Carbon Canister Vacuum Flow

VACUUM COMPONENTS

VACUUM CHECK VALVE/PORTED VACUUM SWITCH

As noted earlier, there are certain vacuum components that are temperature dependent. One of these components is the vacuum check valve (VCV), also referred to as a ported vacuum switch (PVS).

There are three basic types of valves: two-port, three-port, and four-port. These valve types vary from gradient-type to valves with electric switches mounted on top.

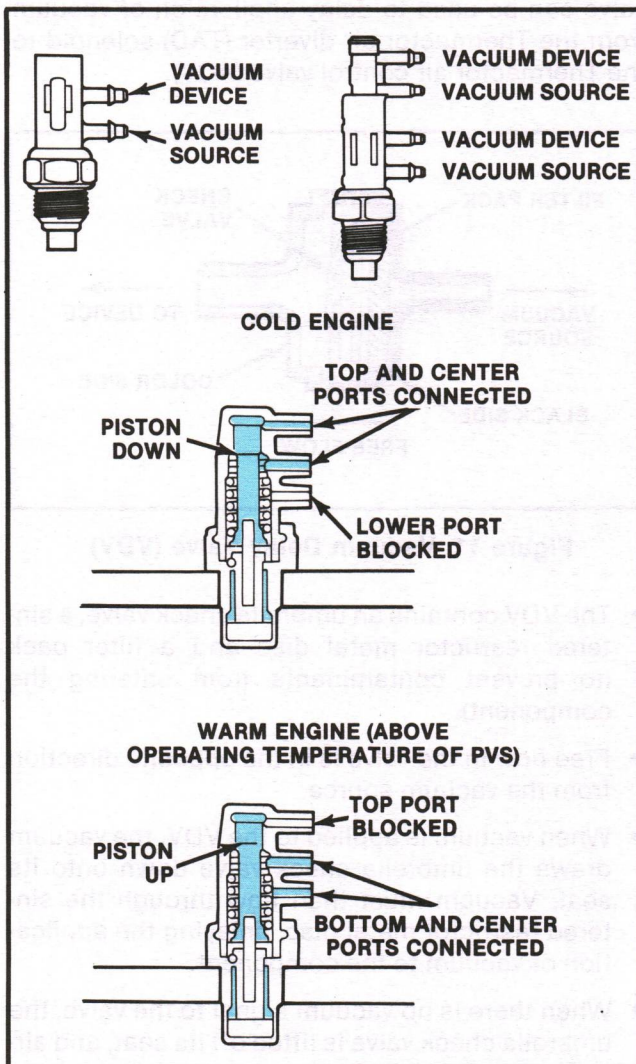


Figure 8. Operation of a Vacuum Check Valve/Ported Vacuum Switch

All vacuum control valves respond to a sensing bulb immersed in engine coolant. As the wax pellet in the bulb is heated, it expands and pushes a rod upward. This rod has passages cut into it. On a three-port valve (Fig. 8), a passage connects the top and middle port, allowing vacuum to flow through these ports. As the wax expands, the top port is closed and vacuum is directed between the bottom and middle ports.

The two-port valves are normally closed valves that open and allow vacuum to flow when a predetermined temperature is reached. A gradient two-port valve is also used. When this valve reaches a predetermined temperature, the valve opens. A bleed orifice on top is used to bleed the output vacuum until a higher engine temperature is reached.

A four-port switch is nothing more than two, two-port switches in one housing. Vacuum is applied to the bottom and third port from the bottom. After reaching a predetermined temperature, the valve opens, which allows vacuum to flow from the bottom port to the second port, and from the third port to the top port. This opening of both valves takes place at the same predetermined temperature.

A three-port valve has vacuum normally applied to the center port. (In some applications, vacuum can be applied to the top and bottom ports.) The bottom port is closed below a calibrated temperature, while the upper port is open. At the predetermined temperature, the top port will close and the bottom port will open to allow a vacuum signal to flow from the center to the bottom port.

TEMPERATURE VACUUM SWITCH

Another type of temperature-dependent component is the temperature vacuum switch (Fig. 9). The temperature vacuum switch (TVS) is a bimetal disc device that allows free airflow in a vacuum line or entirely blocks airflow, depending on temperature.

The bimetal disc of the switch orients itself in one of two positions, depending on its temperature. One position allows free airflow in the vacuum line; the other position blocks airflow by sealing itself against the O-ring.

This device is mounted remotely to, or directly on, the air cleaner. It responds to the temperature of the inlet air heated by the exhaust manifold.

VACUUM SYSTEM

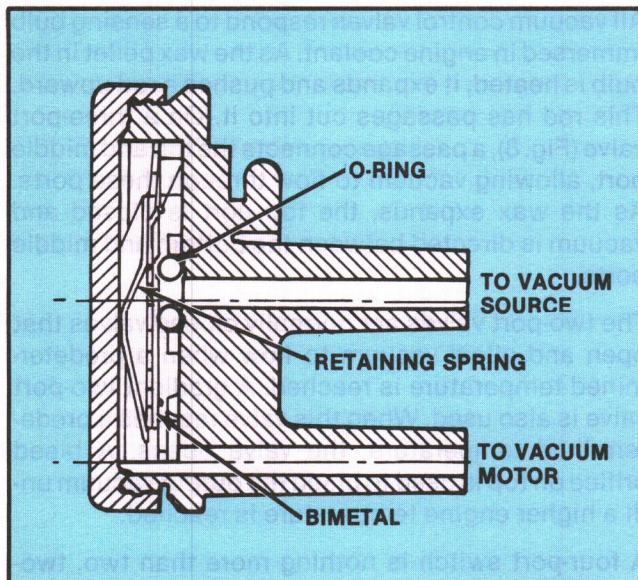


Figure 9. Typical Temperature Vacuum Switch (TVS)

The switching temperature is below the range of normal, stabilized engine operating temperatures. There are five different switches that open or close at different temperatures. These switches are color-coded as follows:

- Open above 24.4 °C (76 °F) maximum **WHITE**
Closed below 10 °C (50 °F) maximum (D5AF-CA)
- Closed above 18.3 °C (65 °F) maximum **RED**
Open below 10 °C (50 °F) (D7EE-AA)
- Open above minus 1.1 °C (30 °F) **BROWN**
Closed below minus 9.4 °C (15 °F) (E1EE-A)
- Open above 12.8 °C (55 °F) **PURPLE**
Closed below 4.4 °C (40 °F) (E2EE-AA)
- Closed above 12.8 °C (55 °F) **GOLD**
Open below 4.4 °C (40 °F) (E3EE-AA)

VACUUM CHECK VALVE

The vacuum check valve (VCKV) is a one-way valve (Fig. 10) that blocks airflow in one direction while allowing airflow in the other direction. It will trap the highest vacuum on the vacuum side (black) of the valve.

All valves use an elastomer diaphragm that is fuel resistant. Care should be taken to avoid particle contamination that can cause excessive leakage.

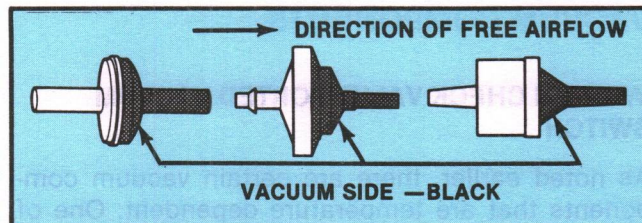


Figure 10. Vacuum Check Valve (VCKV)

VACUUM DELAY VALVE

The vacuum delay valve (Fig. 11) delays the application of vacuum to a vacuum-operated component. On certain applications (2.3L HSC/EEC-IV), this valve can be used to delay application of vacuum from the Thermactor air diverter (TAD) solenoid to the Thermactor air control valve (ACV).

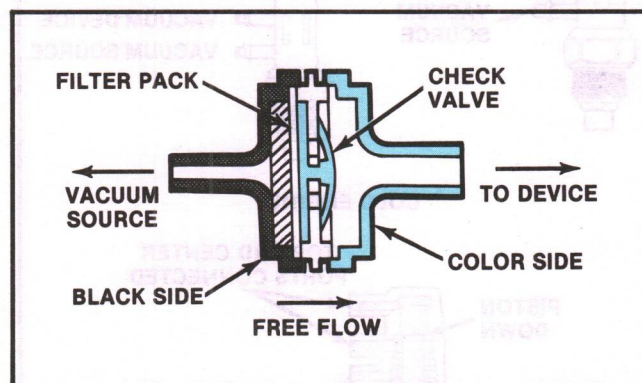


Figure 11. Vacuum Delay Valve (VDV)

- The VDV contains an umbrella check valve, a sintered restrictor metal disc and a filter pack (to prevent contaminants from entering the component).
- Free flow in the valve is in the opposite direction from the vacuum source.
- When vacuum is applied to the VDV, the vacuum draws the umbrella check valve down onto its seat. Vacuum must then flow through the sintered restrictor metal disc, delaying the application of vacuum to the component.
- When there is no vacuum signal to the valve, the umbrella check valve is lifted off its seat, and airflow is not restricted.
- When installing the VDV in a vacuum circuit, the **black** side goes toward the **vacuum source**. The **colored** side goes toward the **device (component)**.

VACUUM RETARD DELAY VALVE

The vacuum retard delay valve (VRDV) (Fig. 12) delays the loss of a vacuum signal to a vacuum-operated component. On certain applications (example, 5.0L EEC-IV/CFI), this valve is used to delay the loss of vacuum from the air cleaner vacuum door during periods of heavy acceleration, such as a wide-open throttle condition. During these conditions, manifold vacuum drops to zero.

If the VRDV is not in the vacuum circuit to the air cleaner door, the door immediately opens, preventing heated air from entering the engine. The VRDV prevents this loss of vacuum for a specific time.

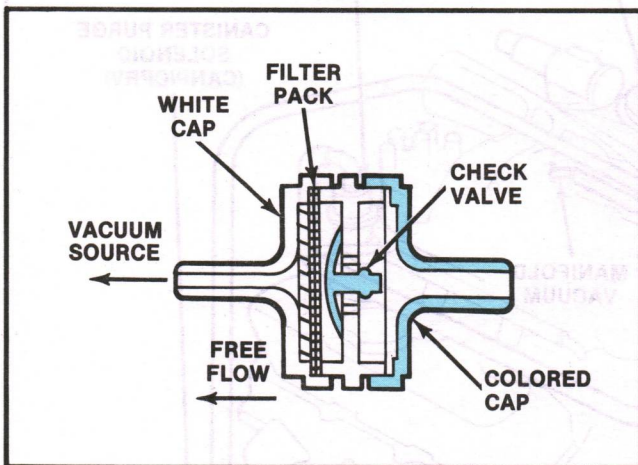


Figure 12. Vacuum Retard Delay Valve (VRDV)

- The VRDV contains an umbrella check valve, a sintered restrictor metal disc and a filter pack (to prevent contaminants from entering the component).
- Free flow in the valve is in the same direction as the vacuum source.
- When vacuum is applied to the VRDV, the vacuum draws the umbrella check valve off its seat. Vacuum then flows through the valve unrestricted.

- When there is no vacuum signal to the valve, the umbrella check valve is drawn onto its seat, and vacuum flow is restricted through the sintered restrictor metal disc, delaying the loss of vacuum to the vacuum-operated component.

When installing the VRDV in a vacuum circuit, the **white** side goes toward the **vacuum source**. The **colored** side goes toward the **device (component)**.

TWO-WAY VACUUM DELAY VALVE

The two-way delay valve (DV-TW) (Fig. 13) restricts airflow equally in either direction. It is commonly used in evaporative emission controls and can be inserted in the vacuum line in either direction.

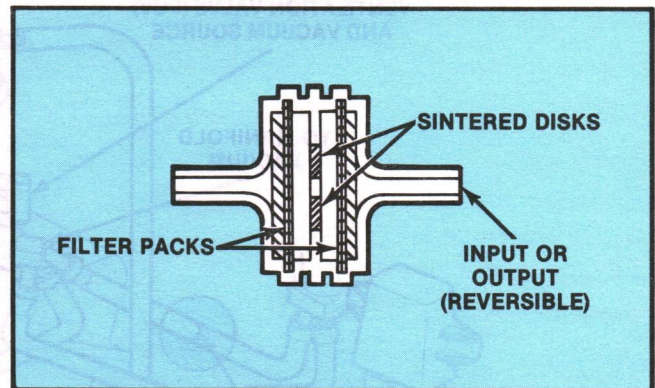


Figure 13. Two-Way Vacuum Delay Valve (DV-TW)

- The DV-TW contains a sintered restrictor metal disc and two filter packs (to prevent contaminants from entering the components).
- Vacuum flow is restricted equally in either direction. **There is no free flow direction in this valve.**
- The vacuum signal is always through a sintered restrictor metal disc.

There are many more vacuum components. To learn about them, refer to the Engine/Emissions Diagnosis Manual, Volume H.

VACUUM SYSTEM

DRIVEABILITY SYMPTOMS AND MALFUNCTIONS

The following examples show how common vacuum system malfunctions can cause specific driveability symptoms.

LEAKING VACUUM HOSE—ROUGH IDLE

A broken vacuum line allows a vacuum leak (Fig. 14). A vacuum leak admits more air into the intake manifold than the engine is calibrated for. Then the engine runs rough due to the leaner air/fuel mixture.

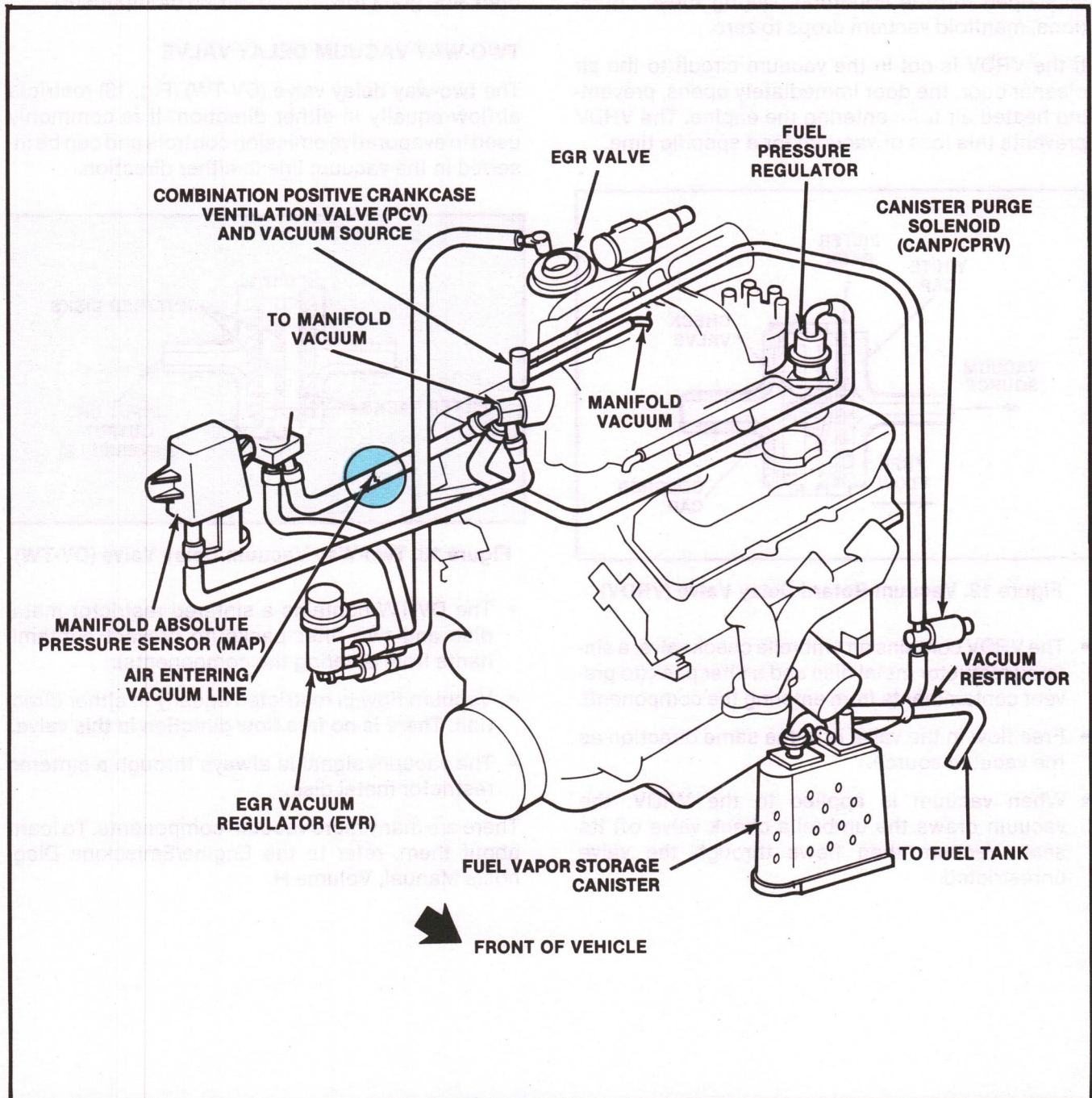


Figure 14. Crack in Vacuum Line

KINKED VACUUM HOSE— SPARK KNOCK/PINGING

If the vacuum hose to the exhaust gas recirculation (EGR) valve is kinked, the exhaust gas recirculation (EGR) valve will not open when required (Fig. 15). The

engine is calibrated to allow a certain amount of exhaust gas to enter the combustion chamber. This not only reduces the amount of NO_x , but also cools down the combustion chamber to prevent spark knock and pinging.

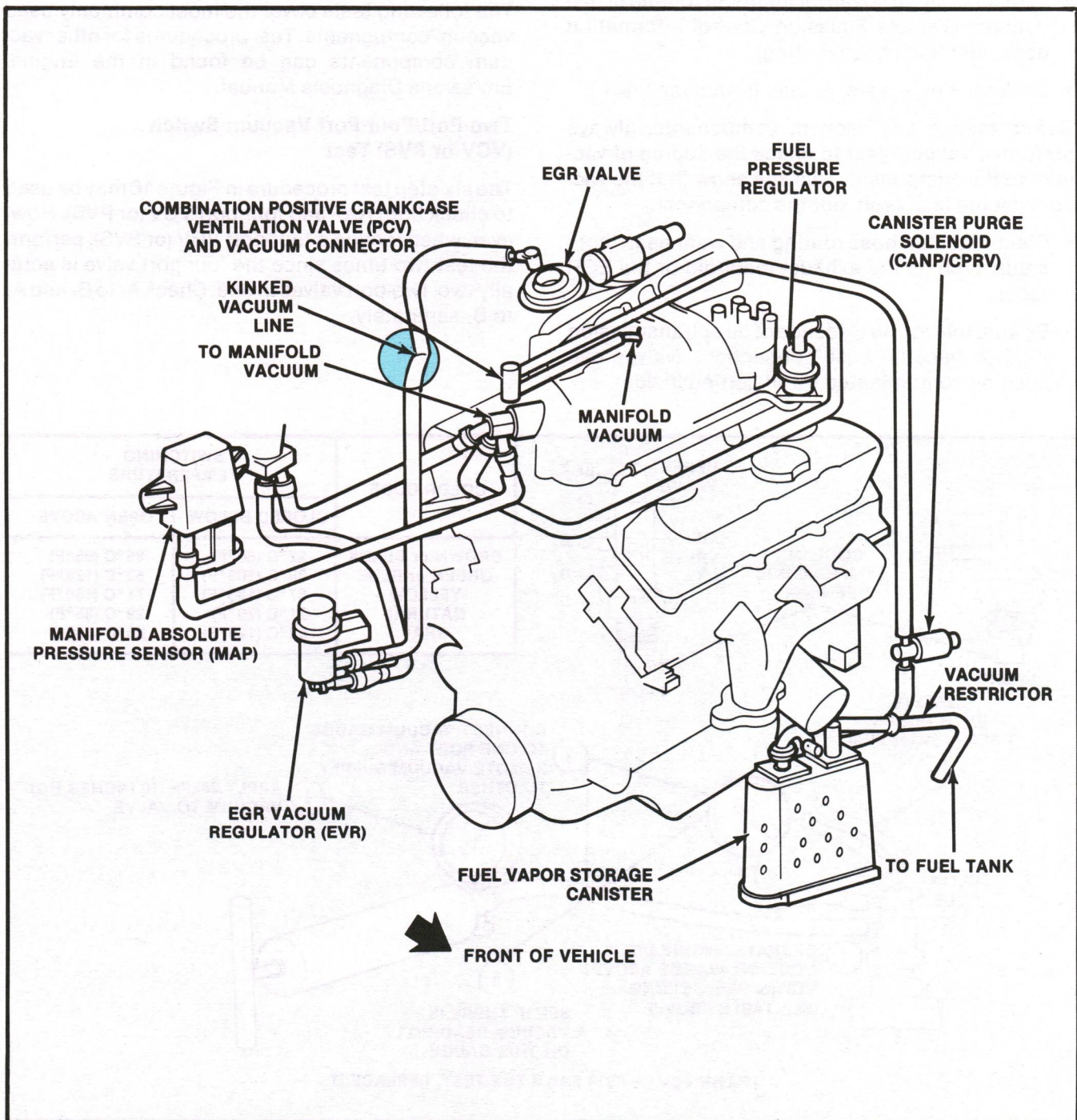


Figure 15. Kinked Vacuum Line to EGR Valve

VACUUM SYSTEM

DIAGNOSIS

INSPECTION

To begin driveability symptom diagnosis for vacuum systems:

- Inspect vacuum hoses for improper routing or disconnect (Vehicle Emission Control information decal identifies hose routing).
- Look for kinks, tears, or cuts in vacuum lines.

Before testing any vacuum components, always perform a vacuum test to check the source of vacuum to the component. This can show that the vacuum source is at fault, not the component.

- Check vacuum hose routing and wear near "hot" spots such as the exhaust manifold or the EGR tubes.
- Be sure there is no evidence of oil or transmission fluid on vacuum hose connections (valves can become contaminated by oil getting inside).

- Inspect vacuum system devices for damage (i.e., dents in cans, bypass valves; broken nipples on VCV or PVS valves; broken "tees" in vacuum lines).

TESTING

The following tests cover the most commonly used vacuum components. Test procedures for other vacuum components can be found in the Engine/Emissions Diagnosis Manual.

Two-Port/Four-Port Vacuum Switch (VCV or PVS) Test

The six-step test procedure in Figure 16 may be used to check both two- and four-port VCV (or PVS). However, when testing a four-port VCV (or PVS), perform the test two times since the four-port valve is actually two, two-port valves in one. Check A₁ to B₁ and A₂ to B₂ separately.

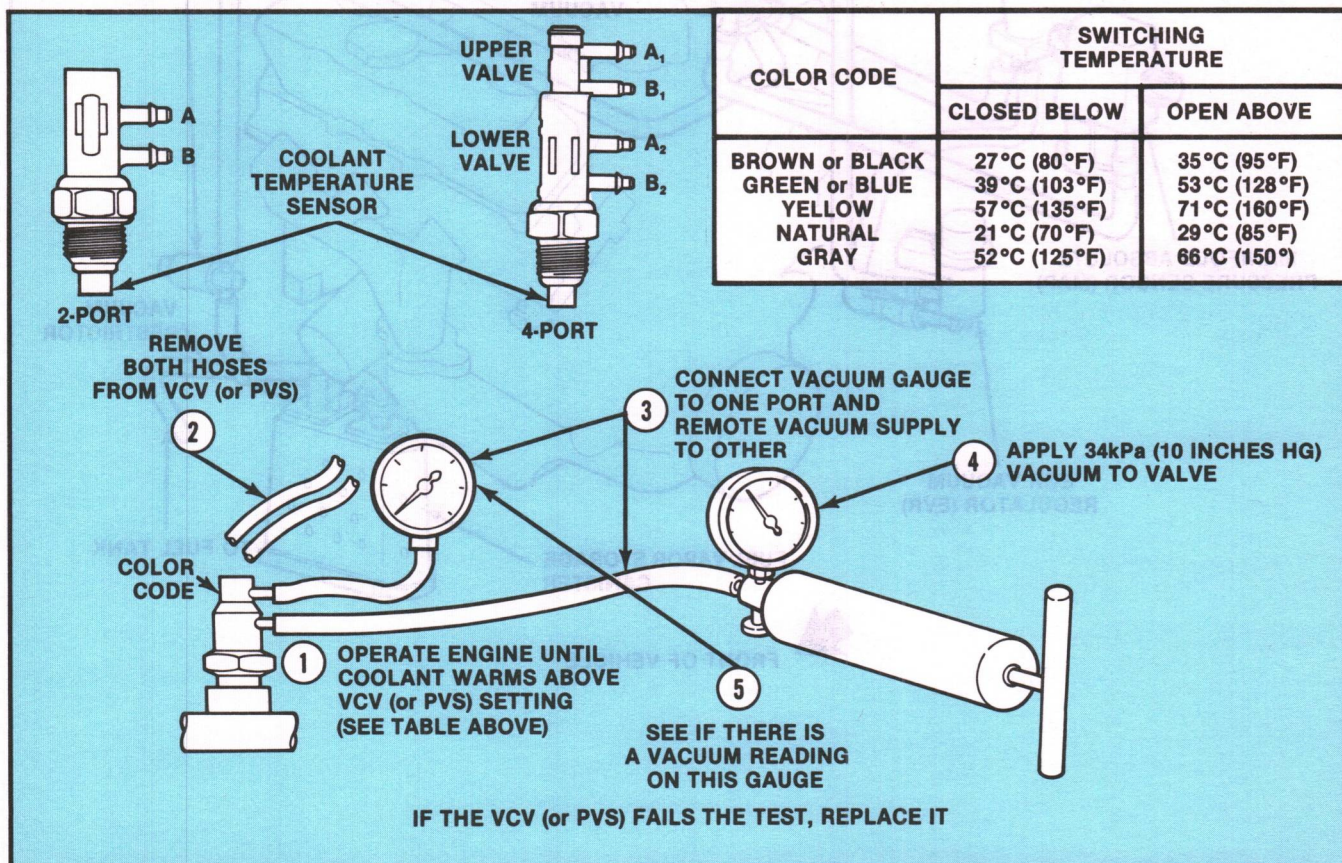


Figure 16. Two-Port/Four-Port VCV or PVS Test

Three-Port Vacuum Switch Test

The three-port VCV or PVS is operating correctly if vacuum at the center port is switched to:

- Upper port with engine temperature below the valve setting (Fig. 17).

- Lower port with engine temperature above the valve setting.

Follow the steps in Figure 17 to test the VCV (or PVS) on the car. If it fails the test, cool the engine, release the radiator pressure, and install a new valve.

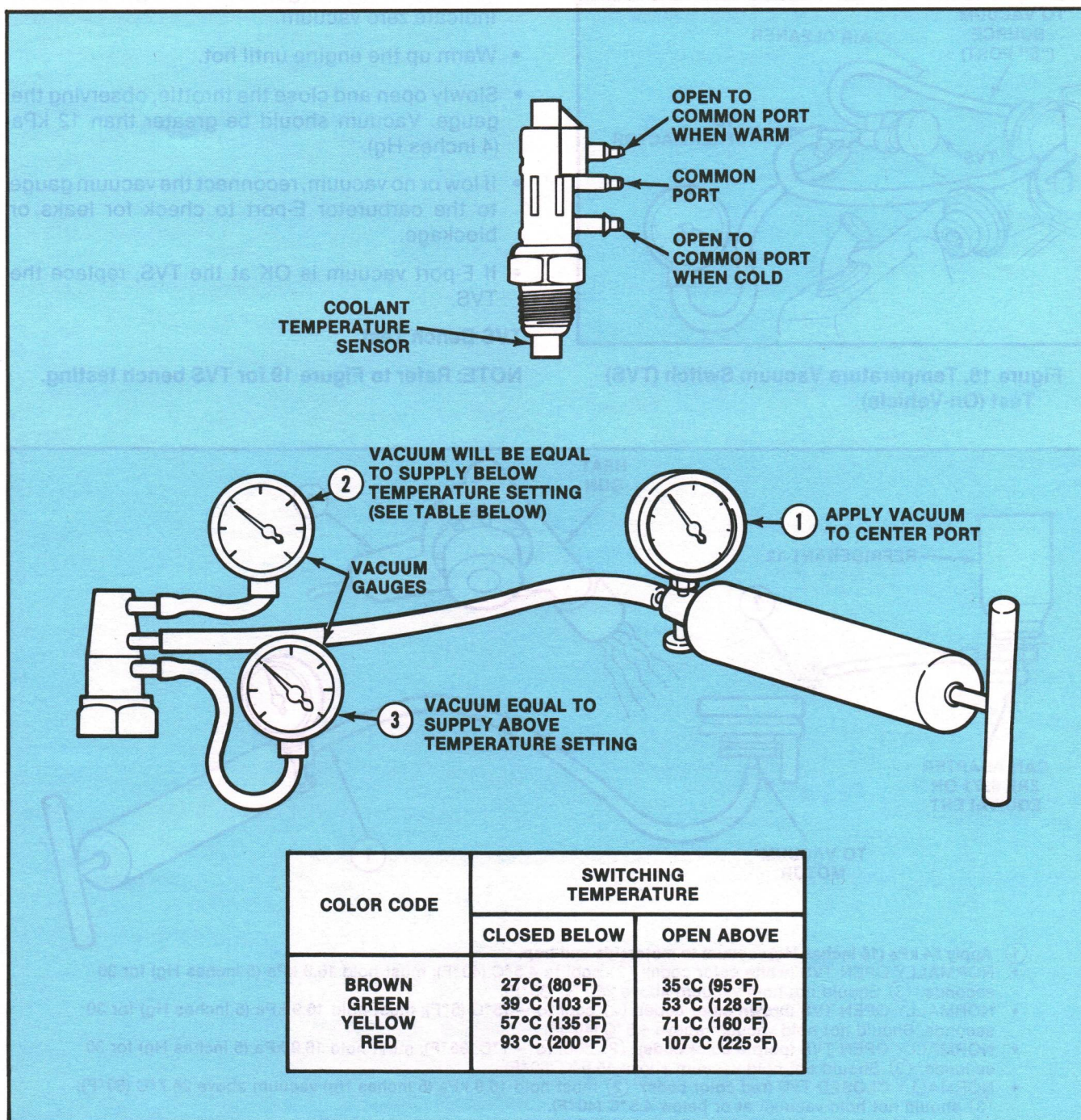


Figure 17. Three-Port VCV or PVS Test

VACUUM SYSTEM

Temperature Vacuum Switch (TVS) Test—On-Vehicle

The TVS is open when warm and closed when cold. Use the following procedure to test the TVS on the vehicle. Refer to Figure 18.

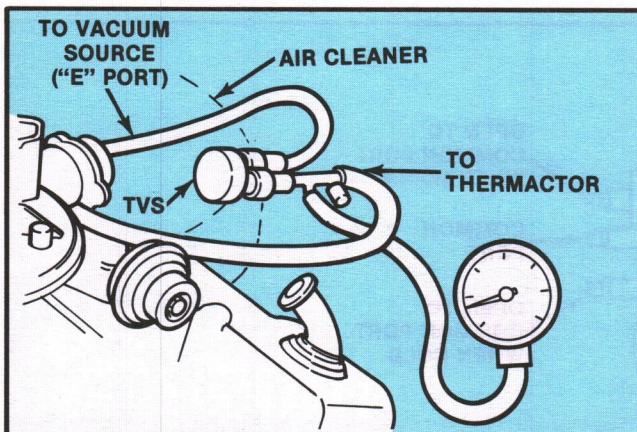


Figure 18. Temperature Vacuum Switch (TVS) Test (On-Vehicle)

- Be sure all vacuum hoses are connected and intact.
- Disconnect the vacuum supply hose to the EGR at the TVS and connect a vacuum gauge.
- Start the engine and slowly open and close the throttle with the engine cold. The gauge should indicate zero vacuum.
- Warm up the engine until hot.
- Slowly open and close the throttle, observing the gauge. Vacuum should be greater than 12 kPa (4 inches Hg).
- If low or no vacuum, reconnect the vacuum gauge to the carburetor E-port to check for leaks or blockage.
- If E-port vacuum is OK at the TVS, replace the TVS.

TVS Bench Test

NOTE: Refer to Figure 19 for TVS bench testing.

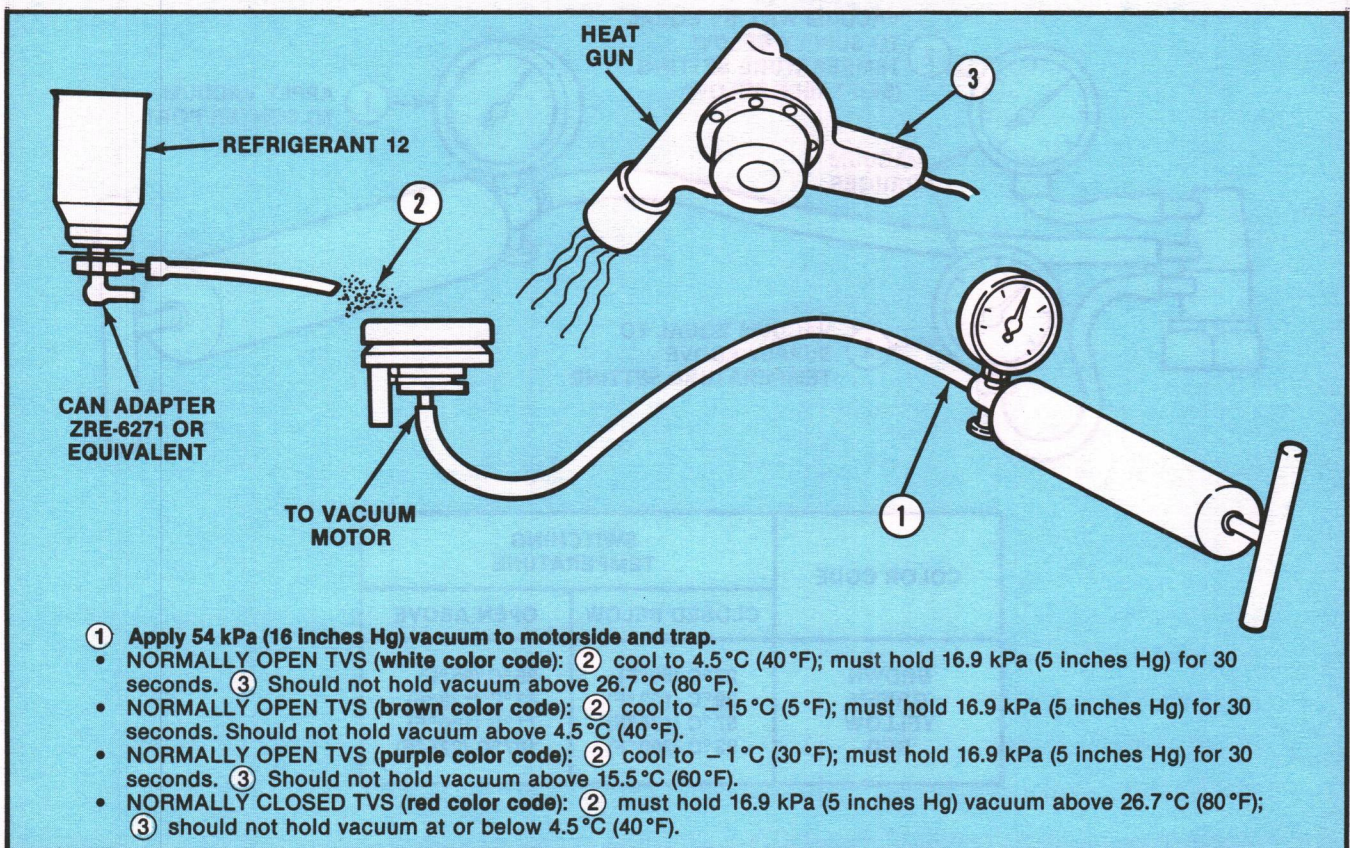


Figure 19. Temperature Vacuum Switch (TVS) Bench Test

Vacuum Check Valve Test

The check valve is okay, if it allows vacuum to flow freely in one direction and traps vacuum applied to the other port.

To test the check valve, connect a vacuum source and gauge to the ports alternately, as shown in Figure 20. Replace the valve, if it fails either test.

Vacuum Delay Valve (VDV), Vacuum Retard Delay Valve (VRDV), and Two-Way Delay Valve (DV-TW) Test

The vacuum delay valve (VDV), vacuum retard delay valve (VRDV), and the two-way delay valve (DV-TW) are all tested in a similar manner. Refer to Figure 21.

- Attach a vacuum pump to the vacuum source side of the valve (white side—VRDV, black side—VDV, either side—DV-TW).

- Attach a vacuum gauge to the colored side of the VDV or VRDV. On the DV-TW, the other side of the valve is attached to the vacuum gauge.

NOTE: Hoses from hand pump-to-device, and from device-to-gauge must be 12 inches long by 5/32 inches.

- Apply 34 kPa (10 inches Hg) of vacuum and trap. Open the bleed valve on the pump to release vacuum.
- Note the time in seconds required to drop from 27 kPa (8 inches Hg) of vacuum to zero. Compare with delay-time specification in the chart (Fig. 21).
- For premature vacuum release or no release, replace the valve.

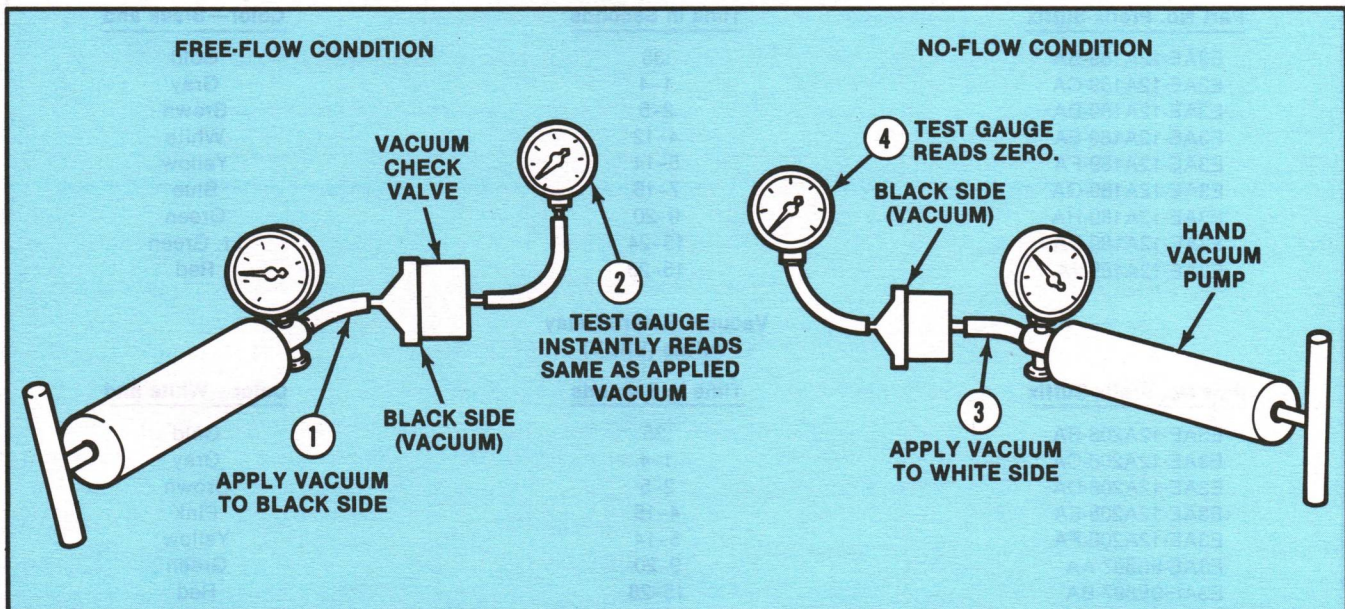


Figure 20. Vacuum Check Valve (VCV) Test

VACUUM SYSTEM

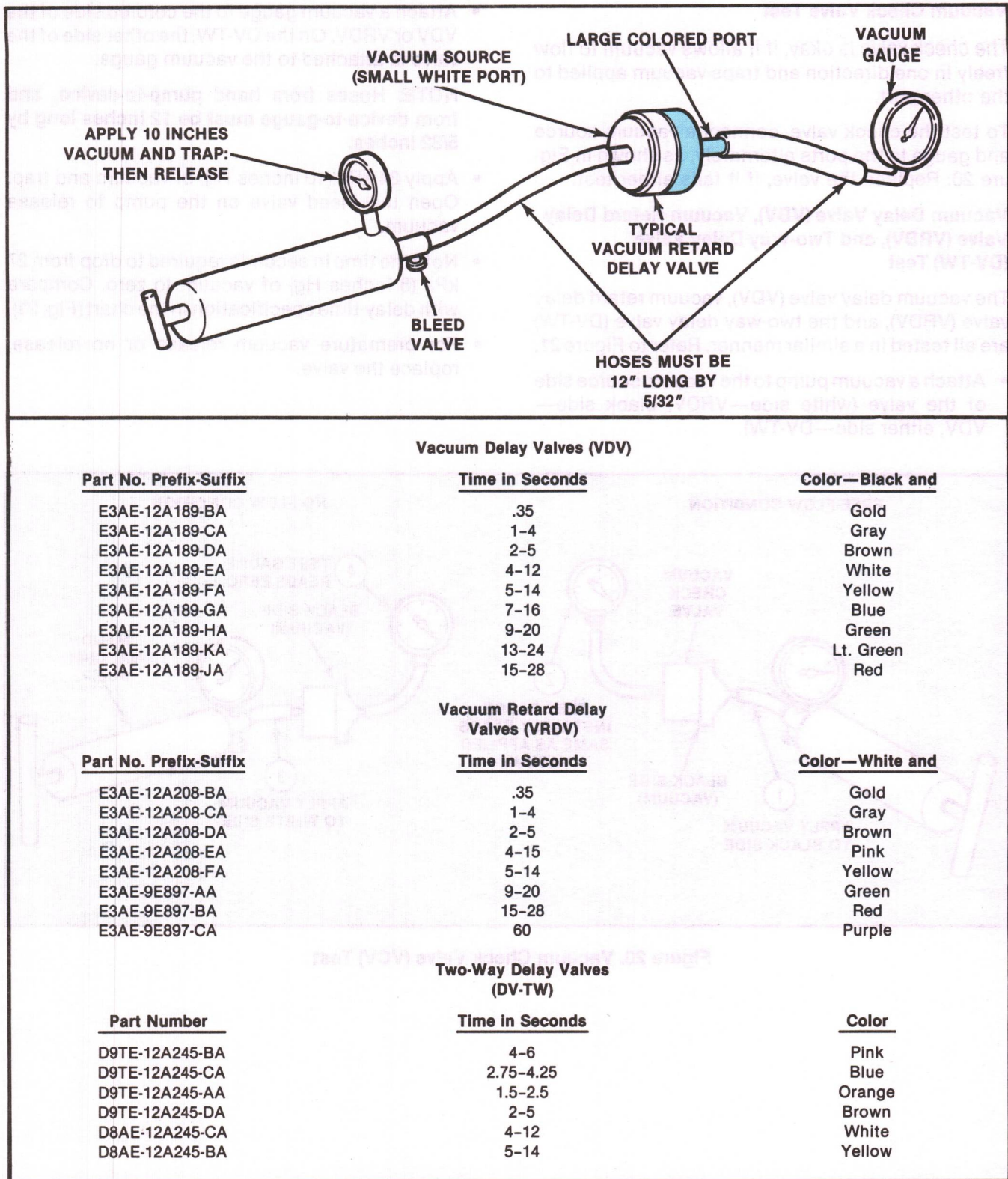


Figure 21. VDV, VRDV, DV-TW Test

IGNITION SYSTEM

OPERATION

The ignition system is made up of basic components, which when incorporated in the proper sequence and at the correct time, ignite the air/fuel mixture in each combustion chamber.

These basic components include the following (Fig. 22):

- Battery
- Ignition switch
- Ignition coil
- Distributor
- Thick-film ignition (TFI) module
- Spark plugs
- Spark plug wires

The ignition system is separated into two circuits: primary (low voltage) and secondary (high voltage). Although these circuits are separate, they do function together and relate closely to each other.

PRIMARY CIRCUIT

The primary circuit provides the current from the battery necessary to energize the ignition system. With the ignition switch in the START or RUN position, power is available to the thick-film ignition (TFI) module. The TFI module switches the ignition coil on-and-off in response to signals from the EEC-IV electronic control assembly (ECA).

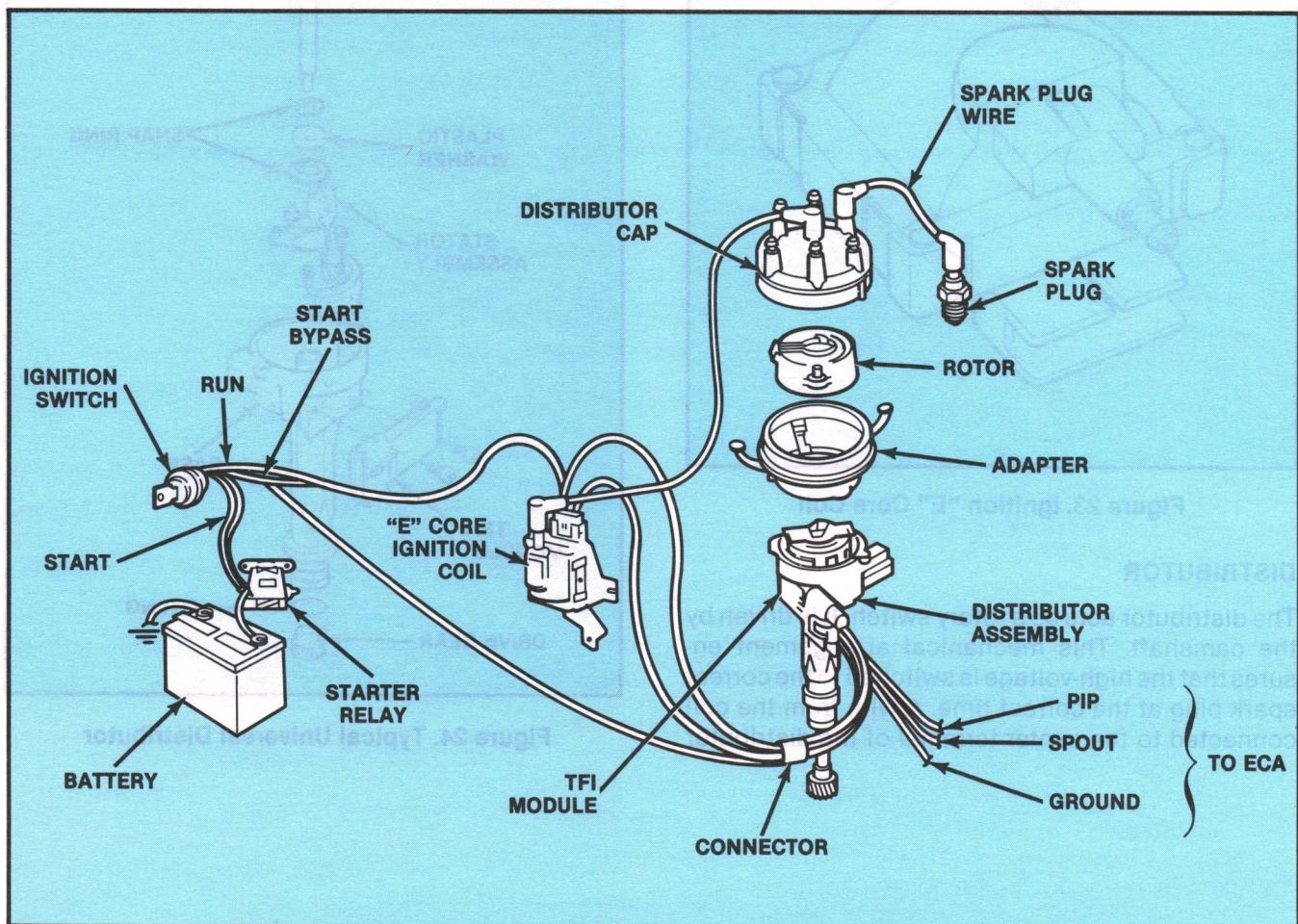


Figure 22. Thick-Film Ignition (TFI) System-IV

IGNITION SYSTEM

SECONDARY CIRCUIT

IGNITION COIL

The ignition coil (Fig. 23) is the link between the primary and secondary circuits. It is a voltage step-up transformer that increases the system voltage to the point where it can jump the gap in the spark plugs. When the coil is energized by the TFI module, a magnetic field is built up around the primary and secondary windings of the coil and reinforced by the "E" core. When the primary circuit is opened by the TFI module, the magnetic field collapses and induces a current into the secondary winding. High-voltage current flows into the distributor cap and on to the correct spark plug.

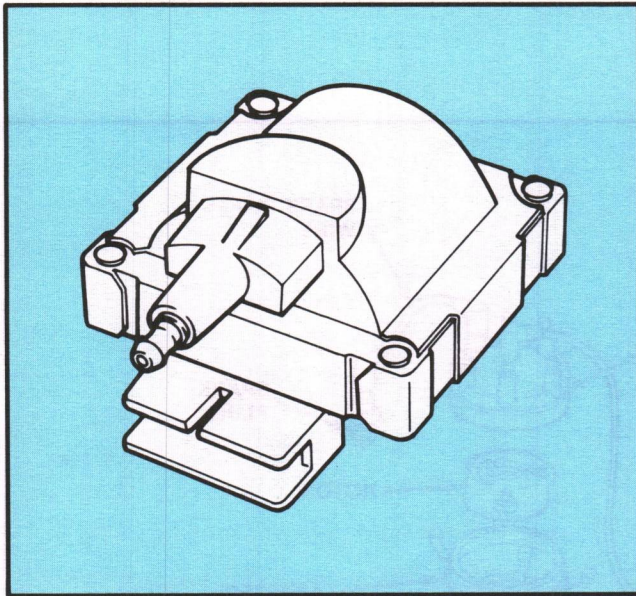


Figure 23. Ignition "E" Core Coil

DISTRIBUTOR

The distributor acts as a rotary switch. It is driven by the camshaft. This mechanical arrangement ensures that the high-voltage is switched to the correct spark plug at the correct time. A wire from the coil connected to the center terminal of the distributor

cap brings the high-voltage current to the distributor. The spark plug wires connect the remaining terminals in the distributor cap to the spark plugs. The rotor makes the connection between the center terminal and the correct spark plug terminal as it is turned by the distributor shaft.

The Universal distributor (Fig. 24) used with the TFI-IV ignition system contains no advance mechanisms. All adjustments of timing and dwell are accomplished electronically. The high-voltage distribution is accomplished through the conventional rotor, cap and ignition wires.

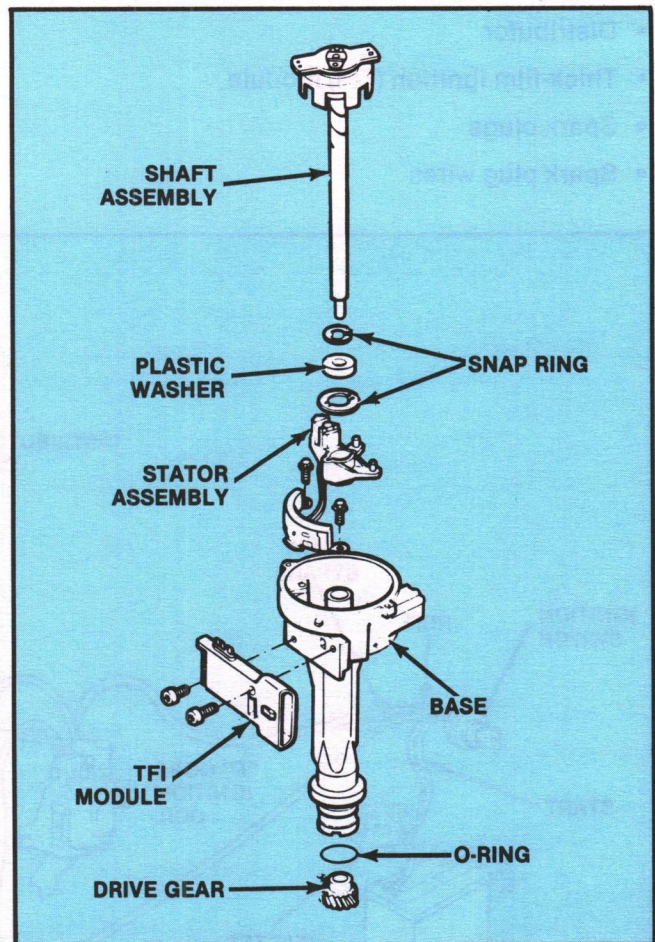


Figure 24. Typical Universal Distributor

SPARK PLUGS

The spark plug provides a path for the high current of the secondary circuit to flow to ground. The only paths for this current are through the ground electrode and center electrode across the spark gap (Fig. 25). The spark produced, when the current jumps the gap, ignites the air/fuel mixture in the cylinder.

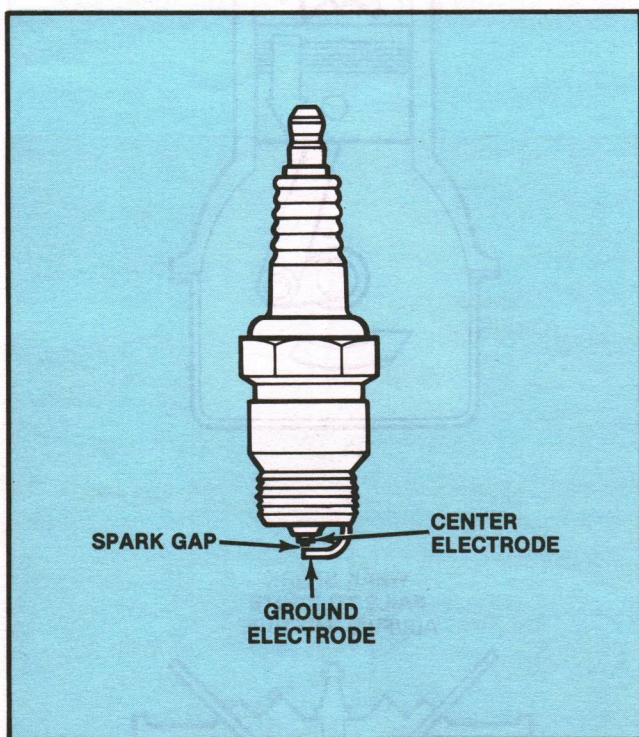


Figure 25. Typical Spark Plug

DRIVEABILITY SYMPTOMS AND MALFUNCTIONS

The next three examples show how common ignition system malfunctions can cause specific driveability symptoms.

WET IGNITION WIRES OR DISTRIBUTOR CAP—CRANKS NORMALLY, BUT WON'T START

Moisture in distributor cap, ignition wires, or at the connections between the coil, distributor and spark plugs (Fig. 26) can cause a short-to-ground. This short will reduce the voltage to the spark plugs. Without enough voltage, the spark plugs will not supply the required spark and, therefore, the engine will not start.

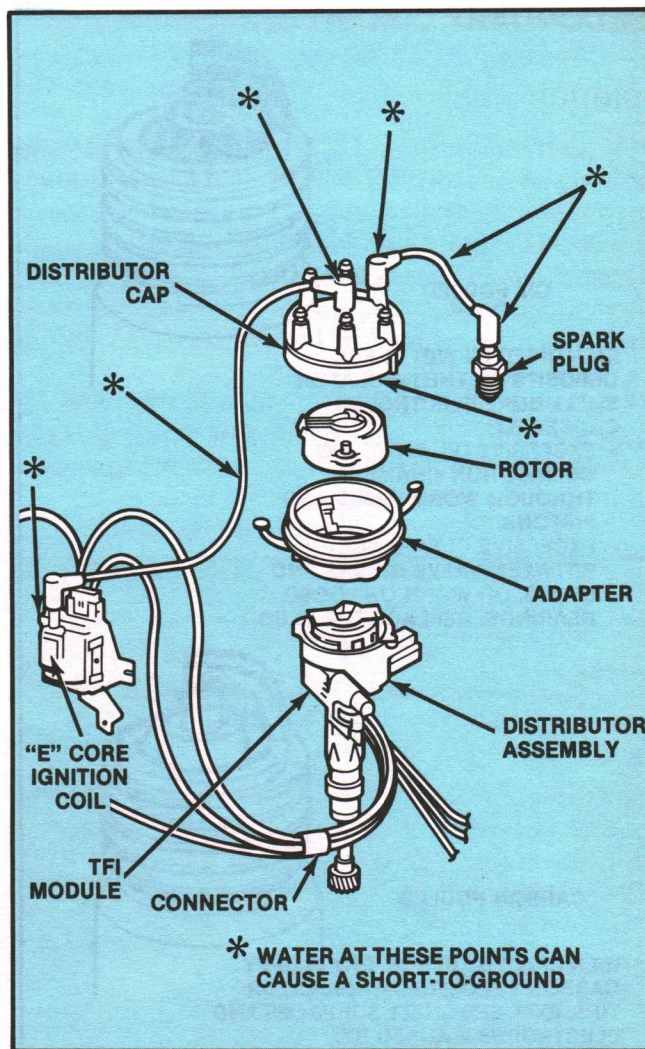


Figure 26. Water in Typical Ignition System

FOULED SPARK PLUGS—MISSES UNDER LOAD, ROUGH IDLE

Since oil and carbon are better conductors of electrical current than air, carbon or oil fouling (Fig. 27) reduces the resistance between the spark plug electrodes. This reduced resistance, from the oil or carbon building up on the spark plug electrodes, causes a lower voltage spark than required to jump the specified air gap between the spark plug. In fact, if the oil or carbon has completely closed the spark plug gap, there will be no spark and that spark plug will not ignite the air/fuel mixture in that cylinder. If one or more spark plugs are fouled, rough idle or missing under load can result.

Note that spark plug fouling is also a sign of other problems. Refer to Figure 27.

IGNITION SYSTEM

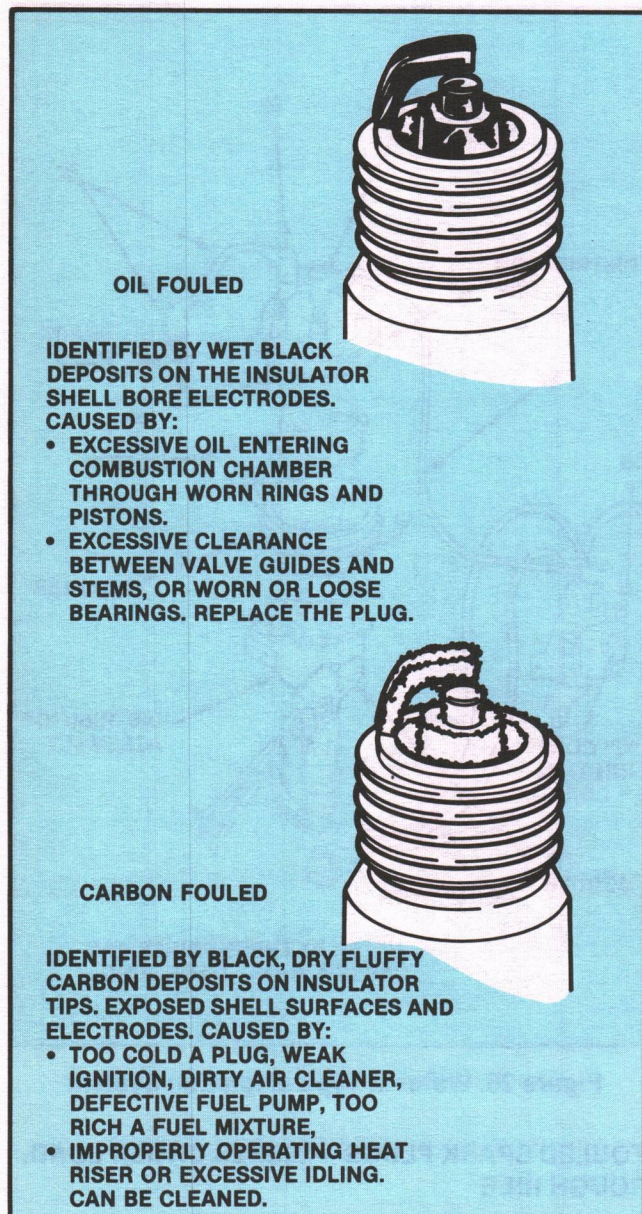


Figure 27. Fouled Spark Plugs

COIL MALFUNCTION—HESITATES, STALLS ON ACCELERATION

If the coil does not fire, there will be no high-voltage pulse to the spark plugs and, hence, no ignition of the air/fuel mixture. If the coil never fires, the engine will not run at all. However, if the coil malfunctions and fires only some of the time, or if it does not produce enough voltage, the engine may hesitate or stall on acceleration. If the spark stays weak (Fig. 28) or if the coil repeatedly fails to fire, fuel may condense and flood the engine, causing a stall.

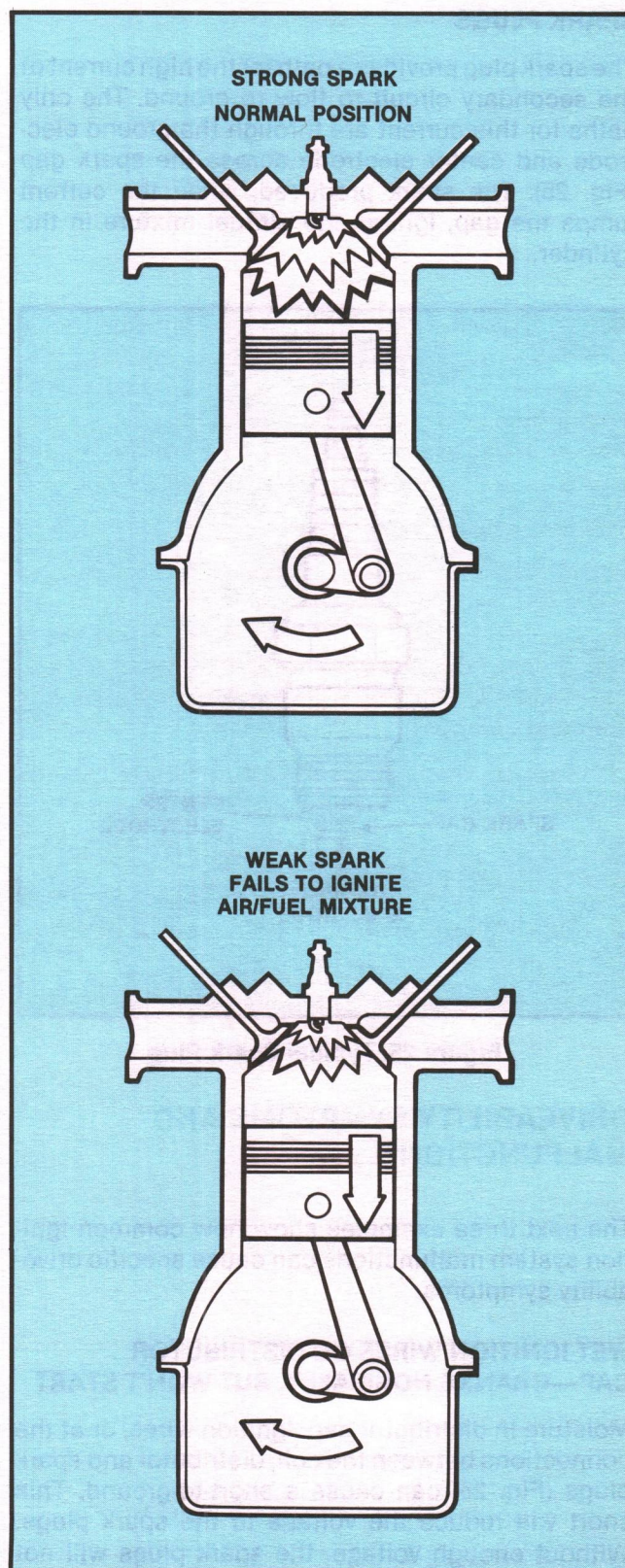


Figure 28. Coil Malfunction Causes Weak Spark

DIAGNOSIS

INSPECTION

For ignition system inspection, always refer to the appropriate Engine/Emissions Diagnosis Manual, Volume H.

TESTING

NOTE: The following tests are typical of the types required to diagnose ignition system problems. For complete ignition system diagnosis, refer to the Engine/Emissions Diagnosis Manual. The engine and all accessories should be OFF for the following tests, unless otherwise instructed.

Setting Base (Initial) Timing

NOTE: The procedure described below for setting initial timing is to be used under normal circumstances. If problems are encountered setting initial timing using this procedure, refer to the spark timing diagnosis procedure in the Engine/Emissions Diagnosis Manual.

1. Place transmission in PARK or NEUTRAL, A/C and heater in OFF position.
2. Connect an inductive timing light, Rotunda No. 059-00006, or equivalent.
3. Disconnect the single-wire connector near the distributor.
4. Start the engine and allow it to warm up to operating temperature.
5. With engine at timing rpm (if specified), check/adjust initial timing to specification.
6. Reconnect single-wire connector and check timing advance to verify distributor is advancing beyond the base setting. If not, refer to the Engine/Emissions Diagnosis Manual.
7. Remove test instruments.

Ignition System Quick Check

For the ignition system quick check, complete the following procedures:

1. With the engine OFF, connect a spark tester between any spark plug wire and engine ground (Fig. 29).

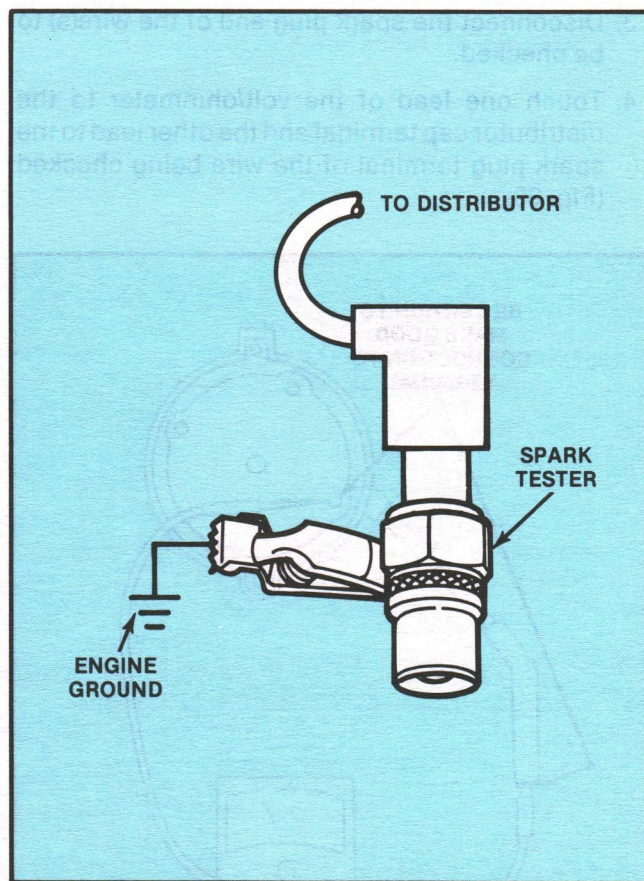


Figure 29. Ignition Coil Wire Check

2. Crank the engine.
3. If there is a good spark, there is no problem with the coil or coil wire. Inspect the distributor cap and rotor as outlined under Inspection. Refer to the Engine/Emissions Diagnosis Manual for further diagnosis procedures.
4. If there is no spark or a weak spark, a problem with the ignition coil, coil wire or primary wiring circuit is likely. Refer to the Engine/Emissions Diagnosis Manual for further diagnosis.

Spark Plug Wire Resistance Check

To check the spark plug wire resistance, complete the following steps:

1. Remove the distributor cap from the distributor.
2. Be sure the spark plug wires are firmly seated on the cap.

IGNITION SYSTEM

3. Disconnect the spark plug end of the wire(s) to be checked.
4. Touch one lead of the volt/ohmmeter to the distributor cap terminal and the other lead to the spark plug terminal of the wire being checked (Fig. 30).

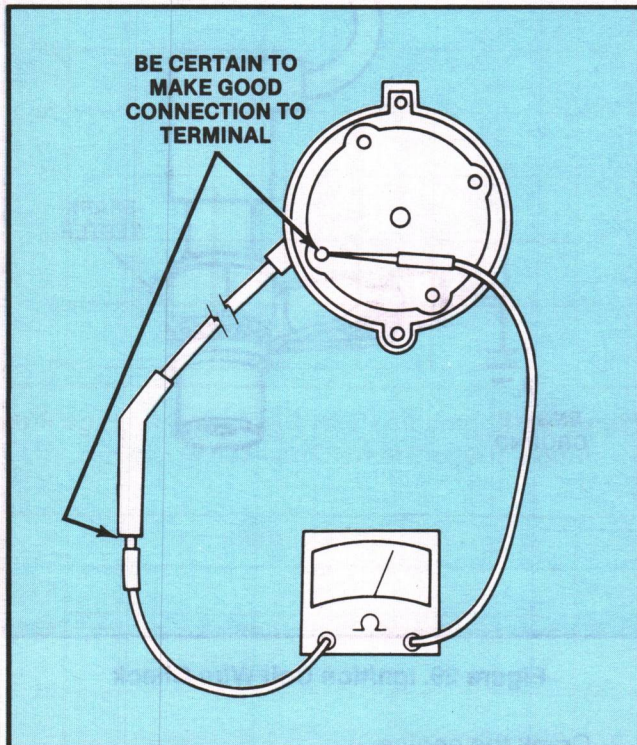


Figure 30. Checking Spark Plug Wire Resistance

5. Read the resistance on the volt/ohmmeter. If it is less than 7,000 ohms-per-foot, the spark plug wire resistance is OK. If resistance is greater than 7,000 ohms-per-foot, replace the wire.

CAUTION: Never puncture a spark plug wire when measuring resistance. Measure only as instructed.

Ignition Primary Circuit Check

To check the ignition primary circuit, complete the following steps:

1. Separate the wiring harness connector from the ignition module. Inspect it for dirt, corrosion, or damage. Reconnect the harness.

NOTE: Push the connector tabs to separate the connector from the module.

2. Attach a 12V DC test light between the coil tach terminal and engine ground (Fig. 31).

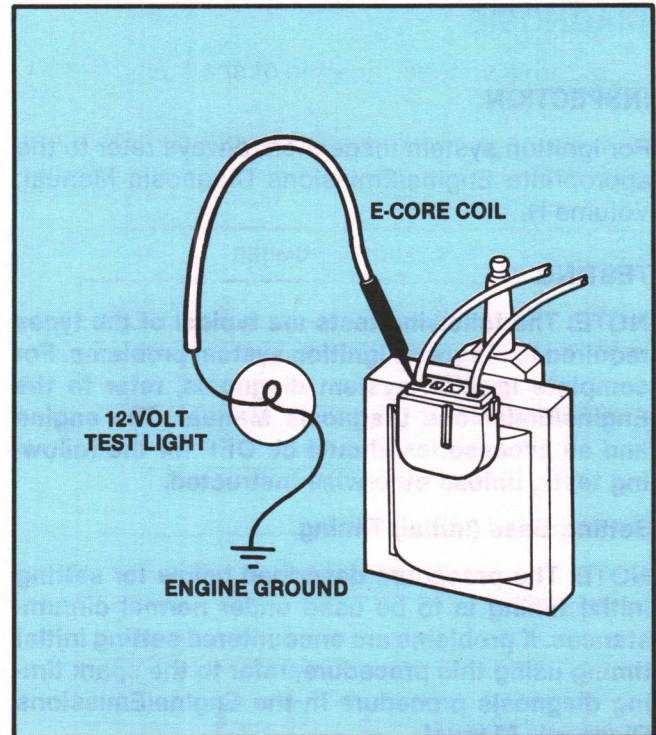


Figure 31. Ignition Coil Firing Check

3. Crank the engine. If the test light flashes, the ignition system problem is somewhere in the ignition secondary circuit. If the light glows constantly, the problem is likely to be in the ignition module, the distributor, or the EEC system. If the light is dim or stays off, there is excessive resistance (or a short or open) in the primary circuit, or the ignition module is malfunctioning.

Spark Plug Firing

NOTE: For the engine analyzer to provide accurate readouts, it must be properly calibrated. Refer to the manual furnished with the analyzer for calibration and hookup procedures.

NOTE: Refer to the Engine/Emissions Diagnosis Manual, Volume H for a three-column format of the following procedures:

1. Connect the engine analyzer to view a parade display of the ignition system secondary circuit.
2. While **slowly** increasing engine rpm from idle to 2000, compare the engine analyzer display to the following illustrations (Figs. 32–37). These illustrations are for a four-cylinder engine, but they are typical for all engines.

3. Figure 32 shows the display for a properly operating ignition system:

- Firing voltage variation of spark plug is 5 KV or less.
- Average spark plug firing voltage is 15 KV or less.

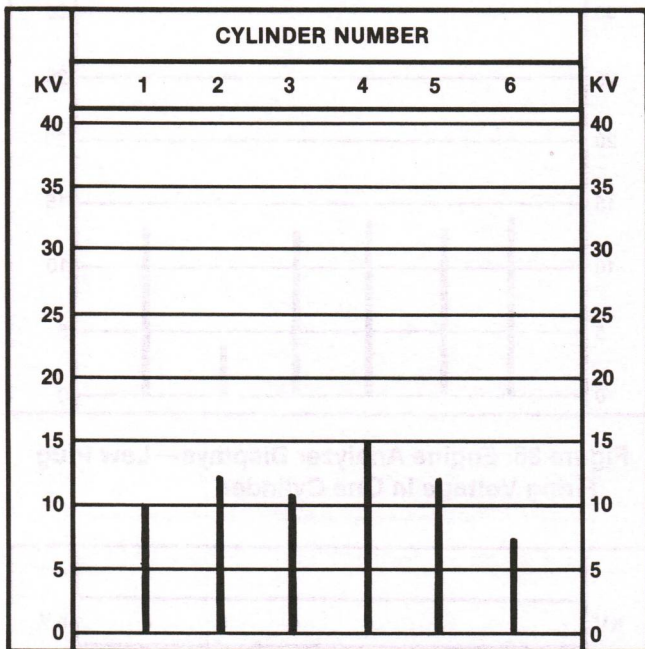


Figure 32. Engine Analyzer Displays—Properly Operating Ignition System

4. If firing voltage variation or spark plug is OK, but average firing voltage is greater than 15 KV, there are problems affecting all cylinders (Fig. 33). Make the following checks and inspections:

- Check ignition coil wire for proper installation in the coil and distributor cap.
- Measure resistance of ignition coil wire. Replace wire, if greater than 7,000 ohms per foot.
- Wide spark plug gaps—all cylinders (usually from worn electrodes due to high mileage).
- Inspect cap and rotor for problems causing excessive cap-to-rotor gap.
- Inspect cap and rotor for lack of silicone compound.

5. If firing voltage variation of spark plug is greater than 5 KV (Fig. 34), the following problems may affect some cylinders:

- Wide spark plug gap(s) or worn electrode(s).
- Improperly installed cap, adapter or rotor.

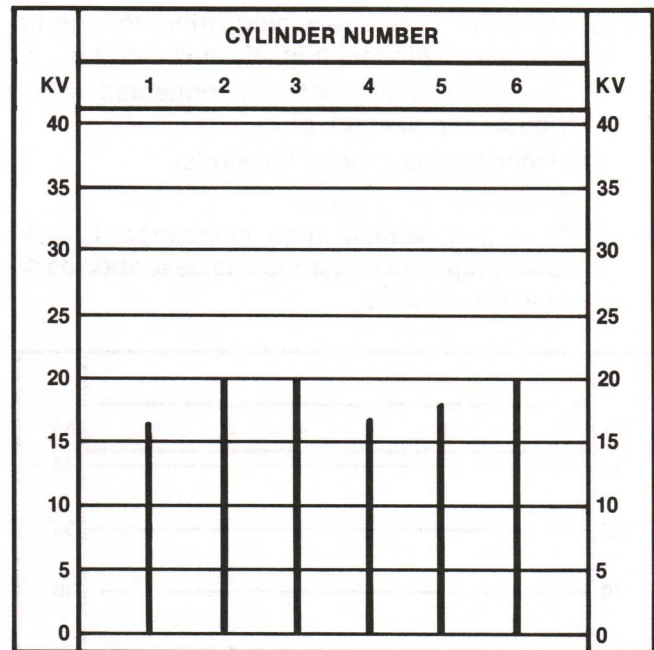


Figure 33. Engine Analyzer Displays—Average Plug Firing Voltage Greater Than 15KV

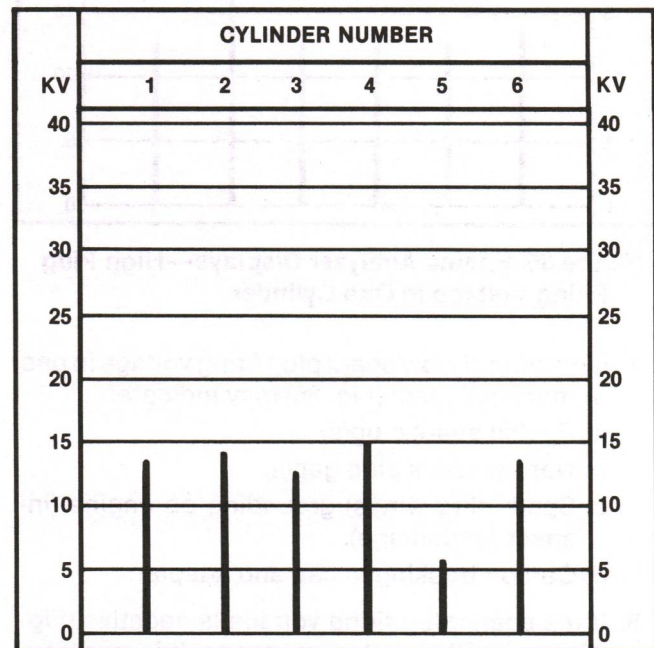


Figure 34. Engine Analyzer Displays—Plug Firing Voltage Variation Greater Than 5 KV

IGNITION SYSTEM

6. Consistently high spark plug firing voltage in one or more cylinders (Fig. 35) may indicate:
- Spark plug wire(s) not firmly connected to distributor cap or spark plug.
 - Disconnected spark plug wire(s).
 - Wide spark plug gap(s).
 - Open plug wire(s), high resistance. Check spark plug wire resistance as described earlier in this Section.

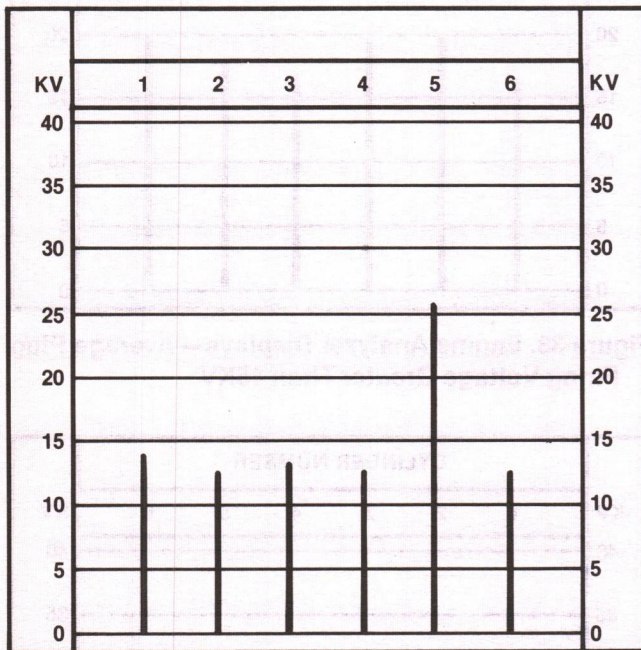


Figure 35. Engine Analyzer Displays—High Plug Firing Voltage in One Cylinder

7. Consistently low spark plug firing voltage in one or more cylinders (Fig. 36) may indicate:
- Fouled spark plug(s).
 - Narrow spark plug gap(s).
 - Spark plug wire(s) grounding on engine (inspect for damage).
 - Carbon tracking in cap and adapter.
8. If the spark plug firing voltage is negative (Fig. 37), the ignition coil primary circuit is reversed. Check the wiring harness to be sure the coil primary circuit is properly connected. If the harness is OK, replace the coil.
9. When testing is complete, disconnect the engine analyzer.

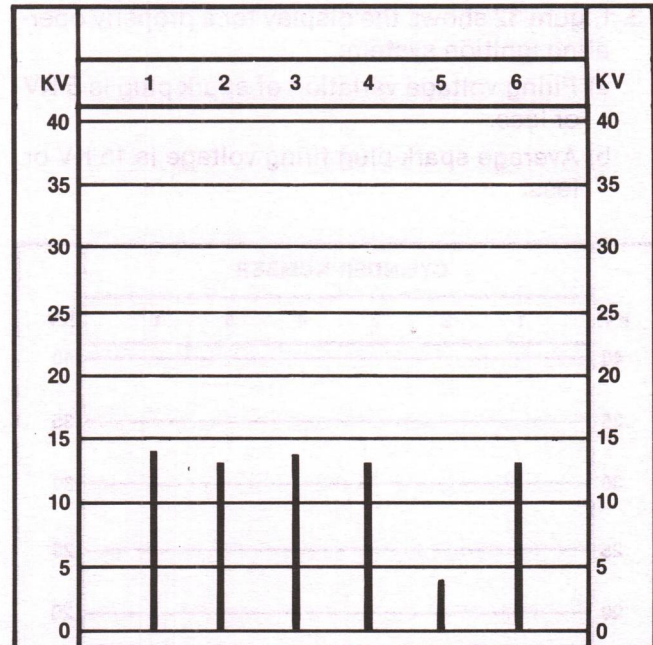


Figure 36. Engine Analyzer Displays—Low Plug Firing Voltage in One Cylinder

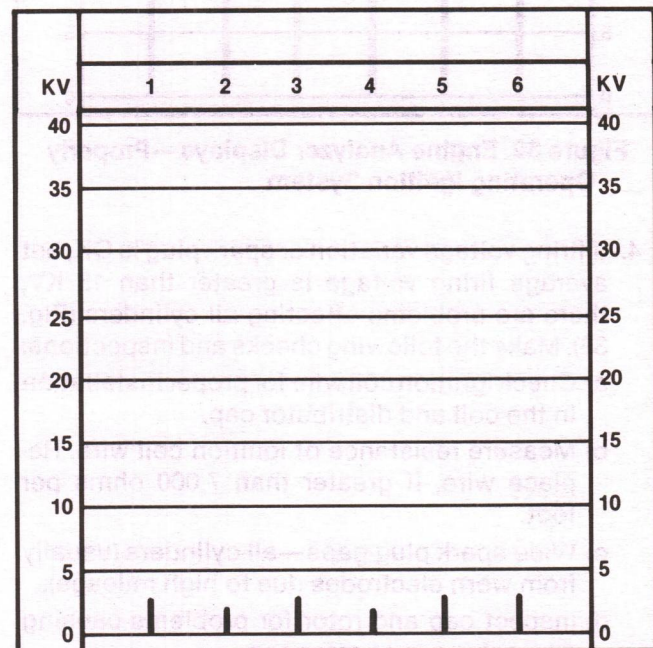


Figure 37. Engine Analyzer Displays—Negative Firing Voltage

MECHANICAL SYSTEM

OPERATION

The basis of automotive gasoline engine operation is the four-stroke cycle. A stroke is the full travel of the piston up or down. The four strokes in this cycle are:

- Intake
- Compression
- Power
- Exhaust

INTAKE STROKE

As the piston moves away from TDC (top dead center), the intake valve opens (Fig. 38). The downward movement of the piston increases the volume of the cylinder above it. This, in turn, reduces the pressure in the cylinder below atmospheric pressure. The reduced pressure causes atmospheric pressure to push a mixture of air and fuel through the open intake valve (Fig. 38). As the piston reaches

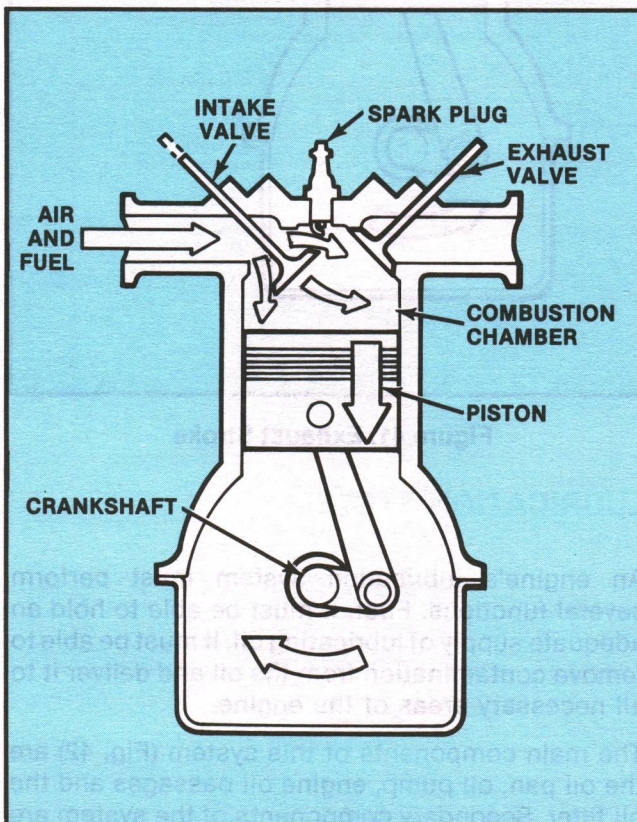


Figure 38. Intake Stroke

the bottom of its stroke, the reduction in pressure stops and the intake of fuel nearly ceases. But due to the weight and movement of the air/fuel mixture, it will continue to enter the cylinder until the intake valve closes. The delayed closing of the intake valve increases the volumetric efficiency of the cylinder by packing as much air and fuel into it as possible.

COMPRESSION STROKE

The compression stroke begins as the piston starts to move from BDC (bottom dead center). The intake valve closes, trapping the air/fuel mixture in the cylinder. Upward movement of the piston compresses the air/fuel mixture (Fig. 39). At TDC, the piston and cylinder walls form a combustion chamber in which the fuel will be burned. The volume of the cylinder (with the piston at TDC) compared to the volume of the cylinder (with the piston at BDC) determines the compression ratio of the engine.

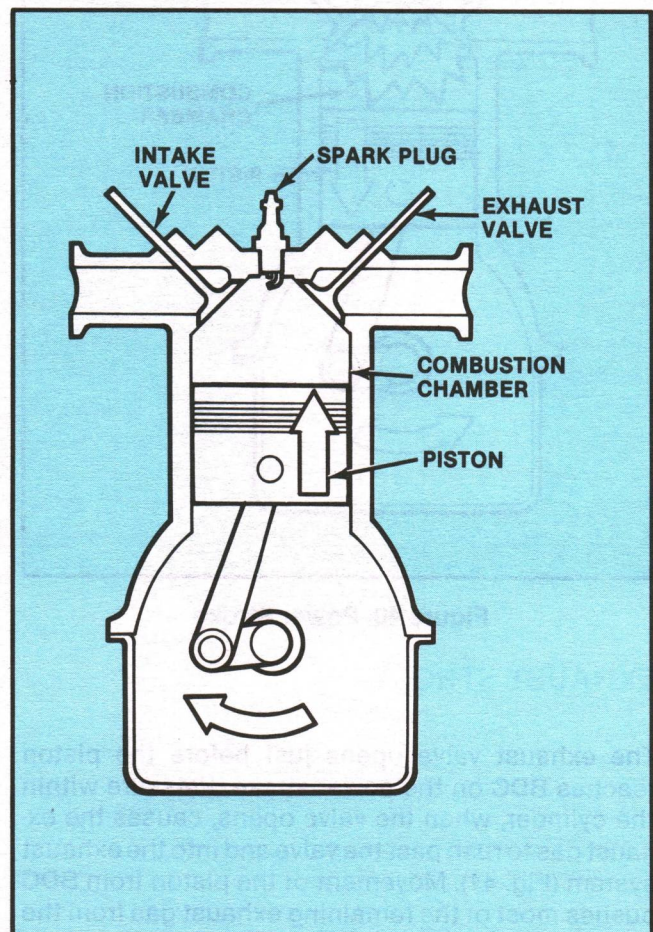


Figure 39. Compression Stroke

MECHANICAL SYSTEM

POWER STROKE

The power stroke begins as the compressed fuel mixture is ignited in the combustion chamber. An electrical spark across the electrode of a spark plug ignites the air/fuel mixture. The burning fuel rapidly expands, creating a very high pressure against the top of the piston. This drives the piston down toward BDC (Fig. 40). The downward movement of the piston is transmitted through the connecting rod to the crankshaft. Up-and-down movement of the piston on all four strokes is converted to rotary motion of the crankshaft.

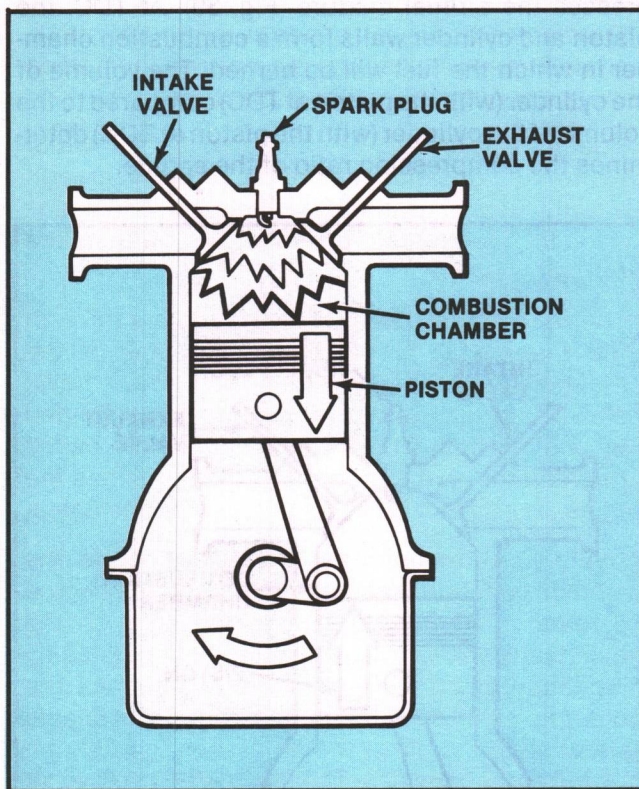


Figure 40. Power Stroke

EXHAUST STROKE

The exhaust valve opens just before the piston reaches BDC on the power stroke. Pressure within the cylinder, when the valve opens, causes the exhaust gas to rush past the valve and into the exhaust system (Fig. 41). Movement of the piston from BDC pushes most of the remaining exhaust gas from the cylinder. As the piston nears TDC, the exhaust valve begins to close as the intake valve starts to open.

Both valves will be open momentarily. This condition is called valve overlap. During valve overlap, incoming air and fuel will continue to purge the cylinder until the exhaust valve closes.

The exhaust stroke completes the four-stroke cycle. The opening of the intake valve begins the cycle again. This cycle occurs in each cylinder and is repeated over and over, as long as the engine is running.

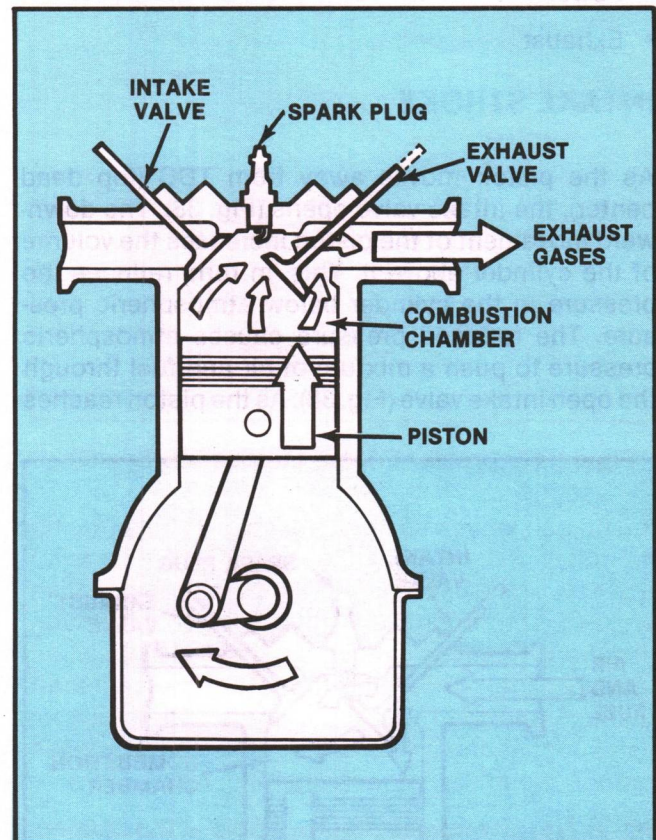


Figure 41. Exhaust Stroke

LUBRICATION SYSTEM

An engine's lubrication system must perform several functions. First, it must be able to hold an adequate supply of lubricating oil. It must be able to remove contamination from the oil and deliver it to all necessary areas of the engine.

The main components of this system (Fig. 42) are the oil pan, oil pump, engine oil passages and the oil filter. Secondary components of the system are the crankcase vent system, oil pressure indicator, oil seals, gaskets and the dipstick.

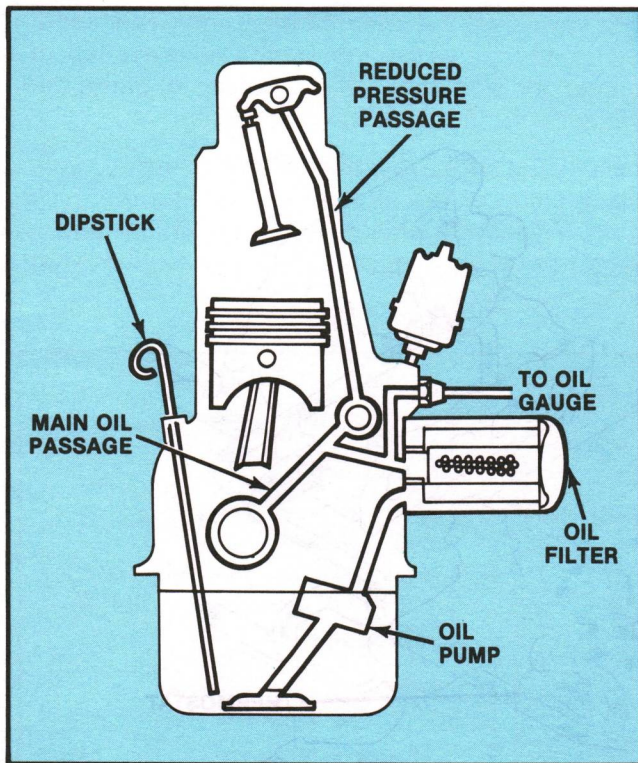


Figure 42. Typical Engine Lubrication System

The oil pan serves as an oil reservoir. The oil pump circulates the oil from the pan at a pressure of 275–414 kPa (40–60 psi). This oil under pressure passes first through the oil filter, then onto the main oil gallery. From the gallery it is directed to the main bearings, the connecting rod bearings, camshaft bearings and the hydraulic tappets. This pressure also supplies the oil sprayed on the cylinder walls through the holes in the connecting rods.

NOTE: Not all engines require a hole in the connecting rod for oil flow to the cylinder walls.

Reduced oil pressure is supplied to other parts of the engine. This reduction is achieved by restricting the size of the oil passage. This is necessary to eliminate engine bearing starvation and excessive oil consumption.

The oil filter removes minute particles from the engine oil to prevent engine wear and to extend the life of the oil. The dipstick measures the amount of oil in the oil pan.

COOLING SYSTEM

The cooling system's job is to remove unwanted heat from the engine and to keep the engine temperature at the right level for efficient operation.

The parts of the cooling system are the radiator, coolant recovery system, radiator pressure cap, the water pump and fan, the thermostat and the hoses that connect these system parts together (Fig. 43).

- The water pump is belt driven by the engine crankshaft. The engine cooling fan may be mounted on the water pump or operated electrically.
- Coolant is pumped or circulated by the water pump from one side tank of the radiator through internal passages in the engine block and heads (Fig. 43). The internal passages are often called the water jacket.
- The water pump then pumps the coolant through the thermostat to the other side tank of the radiator. From one side tank the coolant flows slowly through a system of tiny tubes surrounded by cooling fins. These tubes and fins are called the radiator core. When the coolant reaches the opposite radiator tank, the process begins again.

Actually, from the point the thermostat opens, the coolant is constantly circulated through the engine and radiator. As the coolant travels through the engine block and heads, unwanted heat caused by combustion is transferred to the coolant. As the coolant flows through the radiator core, this heat is transferred to the air as the air passes through the core and around the fins. The fan is used to move air through the radiator when the engine is idling or operating slowly, as in traffic. This ensures sufficient air movement and good heat transfer at slow speeds.

MECHANICAL SYSTEM

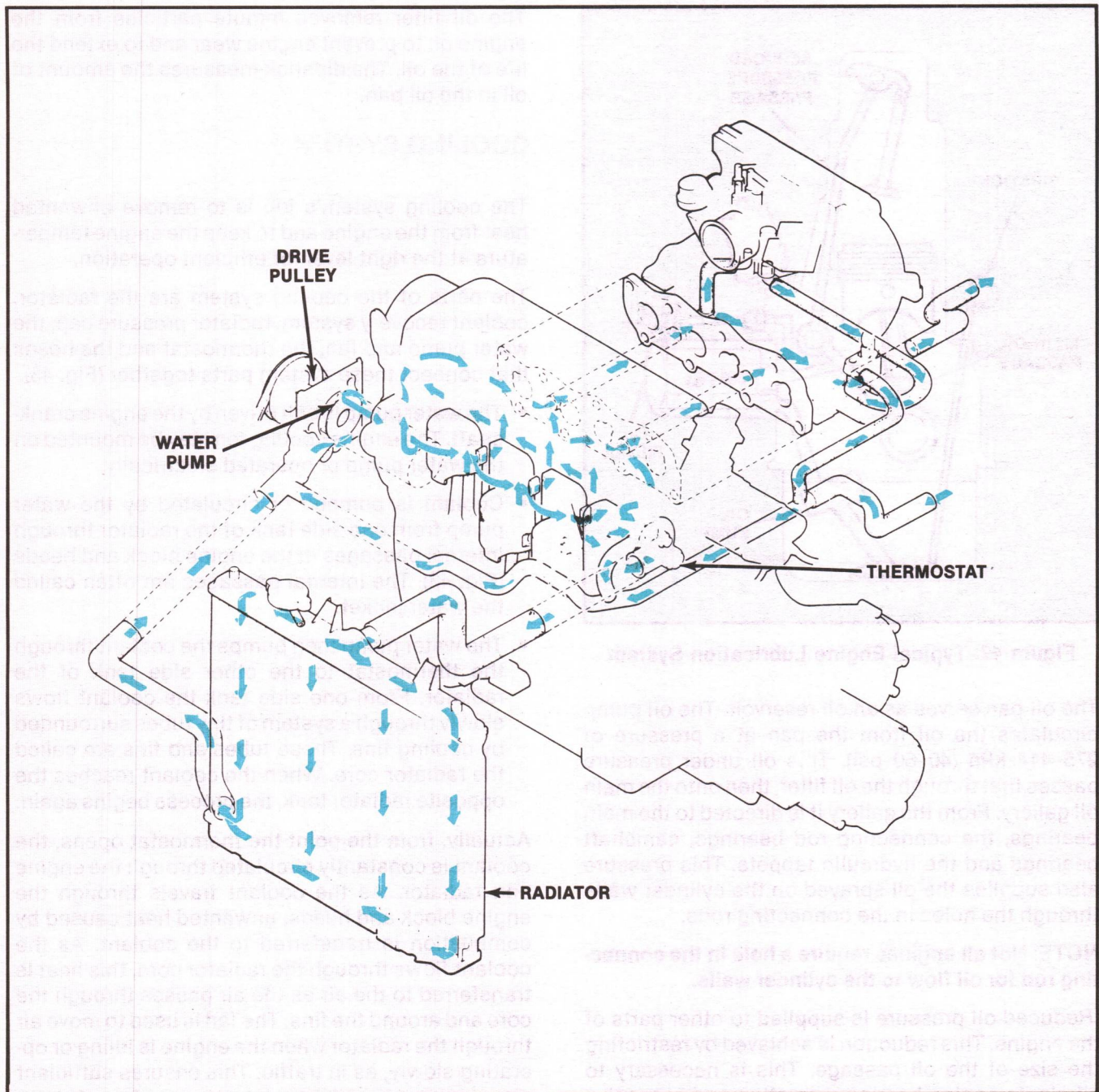


Figure 43. Typical Engine Cooling System

DRIVEABILITY SYMPTOMS AND MALFUNCTIONS

The following three examples are intended to show how some common engine mechanical malfunctions can cause specific driveability symptoms.

WORN PISTON RINGS—HIGH OIL CONSUMPTION, EXHAUST SMOKE

If the piston rings are worn, they may allow oil to leak into the combustion chamber (Fig. 44). This oil will be vaporized on ignition, causing blue exhaust smoke. The vaporized oil is lost to the lubrication system, causing excessive oil consumption.

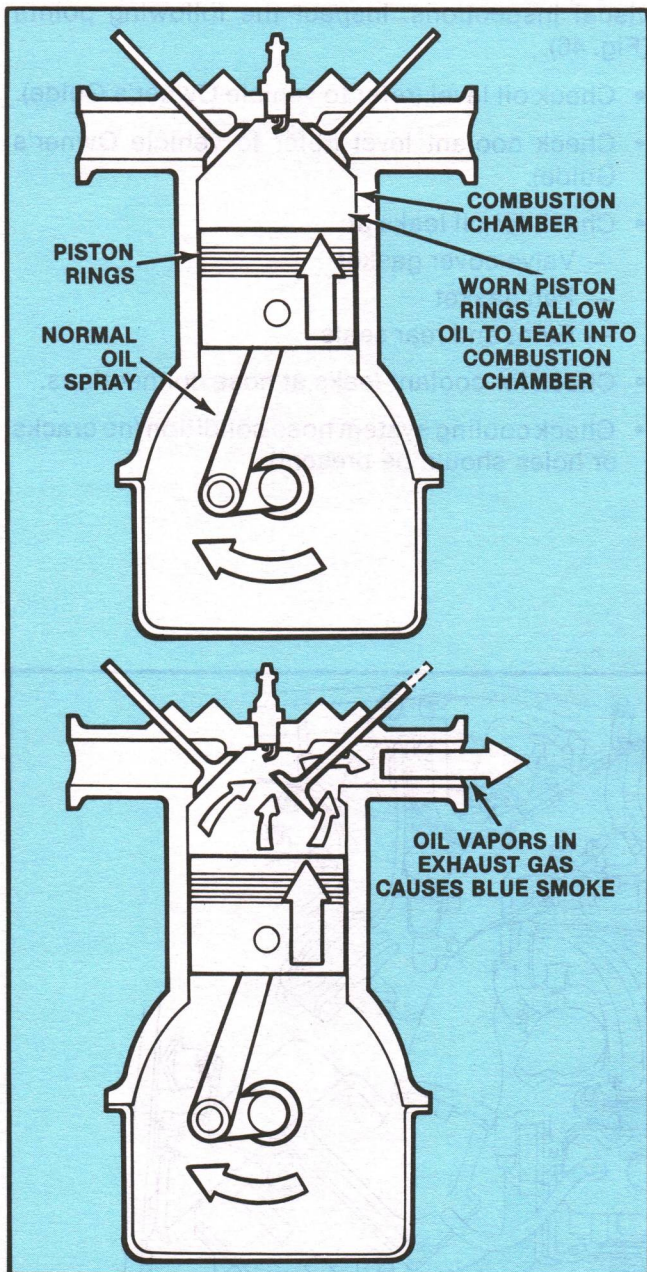


Figure 44. Worn Piston Rings Cause High Oil Consumption, Exhaust Smoke

INTAKE VALVE STICKS OPEN—BACKFIRES

If the intake valve sticks open, the air/fuel mixture will be pushed into the intake manifold on the compression stroke. Then, when the spark plug fires, it ignites not only the air/fuel mixture in the combustion chamber, but also the mixture that escaped into the intake manifold. Igniting the mixture in the intake manifold causes induction backfire (Fig. 45).

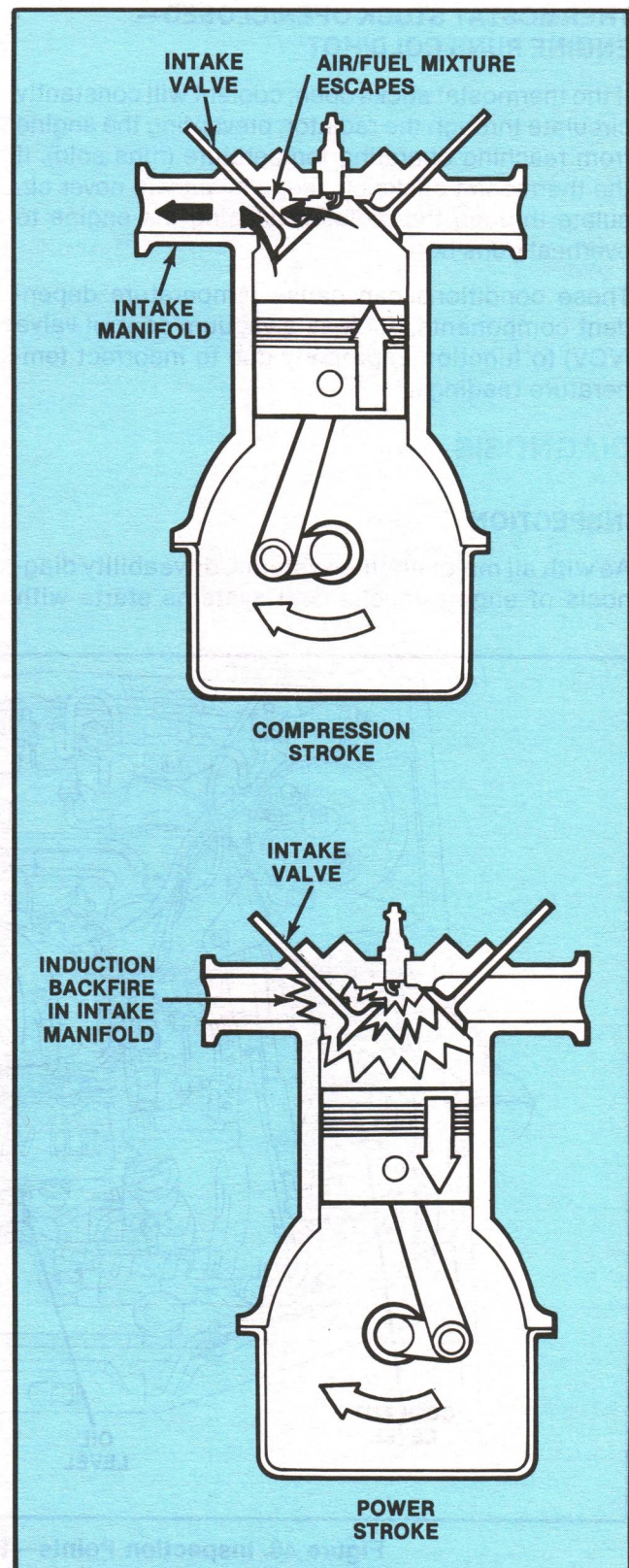


Figure 45. Intake Valve Sticks Open

MECHANICAL SYSTEM

THERMOSTAT STUCK OPEN/CLOSED— ENGINE RUNS COLD/HOT

If the thermostat sticks open, coolant will constantly circulate through the radiator, preventing the engine from reaching operating temperature (runs cold). If the thermostat sticks closed, coolant will never circulate through the radiator, causing the engine to overheat (runs hot).

These conditions can cause temperature dependent components, such as a vacuum control valve (VCV) to function improperly due to incorrect temperature readings.

DIAGNOSIS

INSPECTION

As with all major engine systems, driveability diagnosis of engine mechanical systems starts with

visual inspections. Inspect the following points (Fig. 46).

- Check oil level (refer to vehicle Owner's Guide).
- Check coolant level (refer to vehicle Owner's Guide).
- Check for oil leaks at:
 - Valve cover gasket
 - Pan gasket
 - Front and rear seals
- Check for coolant leaks at hose connections.
- Check cooling system hose condition (no cracks or holes should be present).

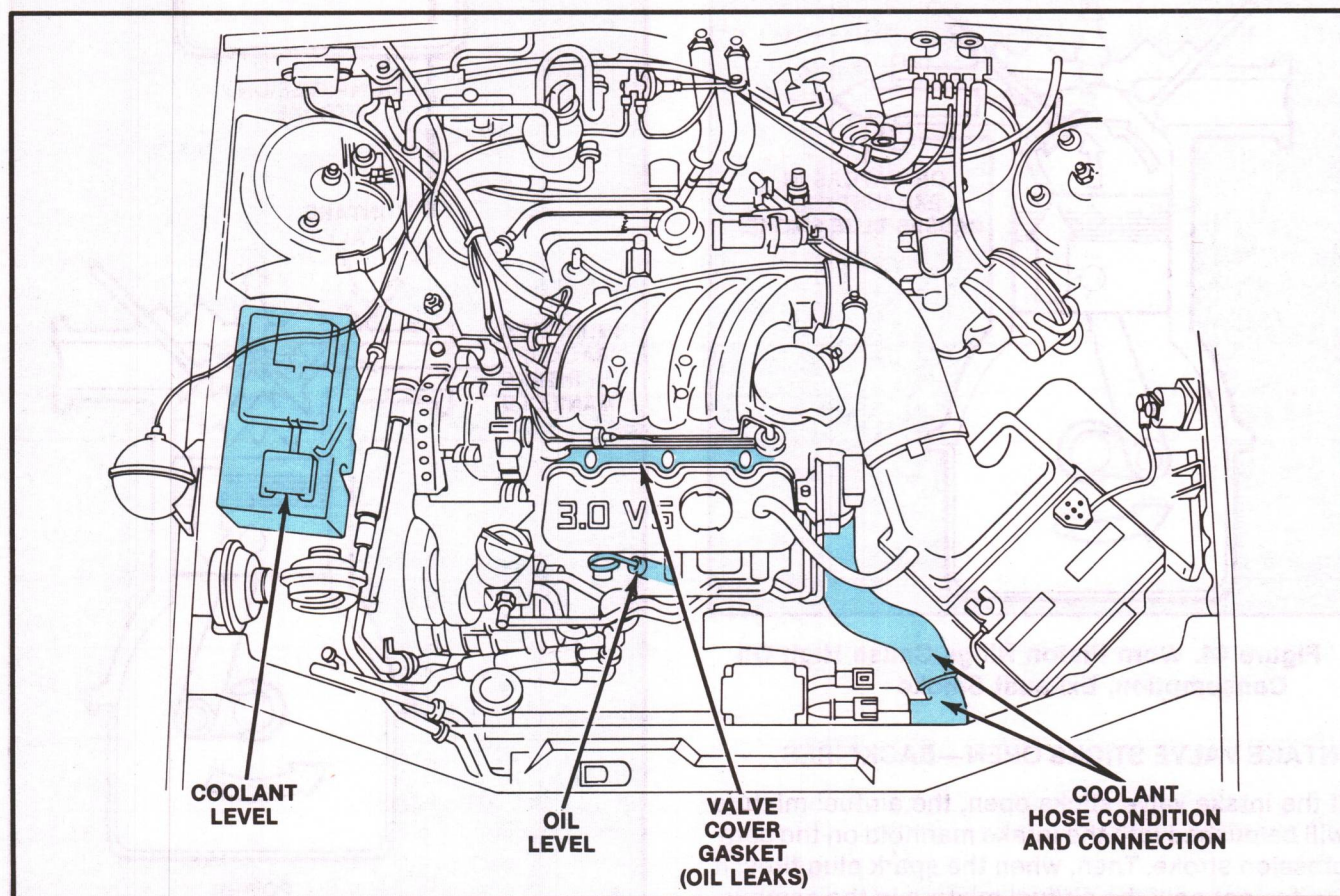


Figure 46. Inspection Points—Engine Mechanical Systems (3.0L)

TESTING

Manifold Vacuum Test

A manifold vacuum test can reveal a number of different types of mechanical problems. To perform a manifold vacuum test:

- Disconnect the intake manifold vacuum line at the manifold and install a vacuum gauge in the line with a "T" fitting, or install it on an empty port of the vacuum tree (Fig. 47).
- Set the transmission selector in NEUTRAL.
- Operate the engine at the specified idle rpm (see vehicle emissions control information [VECI] decal in engine compartment).
- Check and record the reading on the vacuum gauge.
- Compare the reading with the chart (Fig. 48).

The chart lists vacuum gauge readings and the probable engine condition that could be a result of vacuum conditions. Remember, more than one factor can be the cause of an abnormal gauge reading. There are many problems outside the engine mechanical system that can cause an abnormal gauge reading. If the following chart indicates that a mechanical malfunction is a possibility, further diagnosis is required to verify the cause of the problem.

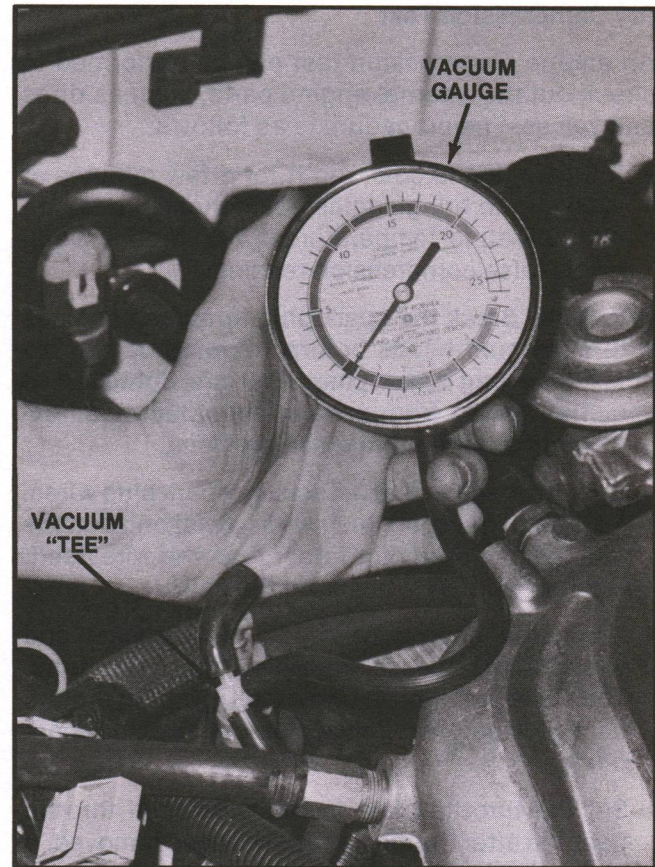


Figure 47. Installing Vacuum Gauge for Manifold Vacuum Test

VACUUM GAUGE READING	PROBABLE ENGINE CONDITION
15-22 IN.	NORMAL
LOW AND STEADY	LOSS OF POWER IN ALL CYLINDERS • LATE IGNITION • INCORRECT VALVE TIMING LOSS OF COMPRESSION • LEAKAGE AROUND PISTON RINGS
VERY LOW	LEAK—INTAKE MANIFOLD, CARBURETOR SPACER OR CYLINDER HEAD GASKET
NEEDLE FLUCTUATES STEADILY AS SPEED INCREASES	PARTIAL OR COMPLETE LOSS OF POWER (ONE OR MORE CYLINDERS) • LEAKING VALVE, CYL. HEAD OR INTAKE MANIFOLD GASKETS • DEFECTIVE IGNITION SYSTEM
GRADUAL DROP IN READING AT ENGINE IDLE	EXCESSIVE EXHAUST SYSTEM BACKPRESSURE
INTERMITTENT FLUCTUATION	OCCASIONAL LOSS OF POWER • DEFECTIVE IGNITION SYSTEM • STICKING VALVE
SLOW FLUCTUATION OR DRIFTING OF THE NEEDLE	• IMPROPER IDLE MIXTURE ADJUSTMENT • LEAK AT CARBURETOR SPACER OR INTAKE MANIFOLD GASKET

Figure 48. Manifold Vacuum Test Readings

MECHANICAL SYSTEM

Dry Compression Test

An engine compression test can be performed to check out the internal engine parts, such as rings and valves. The procedure is as follows:

- If the engine is cold, run it for a few minutes at 1200 rpm to bring engine components up to normal operating temperatures. A cold engine will give a false compression reading.

CAUTION: Break the spark plug torque on engines with aluminum heads before warming up the engine. Removing spark plugs that are tightened to specified torque from a warm aluminum head engine could strip the threads in the head.

- Stop the engine, and detach the spark plug wires. To detach the spark plug wires, twist and pull the molded cap protector rather than the wire itself. Remove primary wires from the coil.
- Using the appropriate spark plug socket and wrench, loosen each spark plug one or two turns. Then, use an air hose to blow all dirt from around each plug before removal. Remove all of the spark plugs.
- Set the throttle plate in the wide-open throttle position after the air cleaner has been removed. If the engine is equipped with a carburetor, also set the choke plate to the wide-open throttle position.

NOTE: On vehicles equipped with a vane meter, remove air intake duct hose from the throttle body before doing a compression test.

- Install a compression gauge in the cylinder (Fig. 49). Then connect a starter remote control cable, or get someone to crank the engine while making the tests.



Figure 49. Compression Gauge Hookup—Dry Compression Test

- Crank the engine at least five or six complete compression strokes to obtain the highest possible reading. Record the readings. Repeat the test on each of the cylinders, using the same number of strokes for each cylinder.

The following chart (Fig. 50) shows the compression gauge reading and probable engine condition for that reading.

If all cylinders test according to the specifications in the Shop Manual and are within 75 percent of the highest reading, the overall compression of the engine is satisfactory.

COMPRESSION GAUGE READING	PROBABLE ENGINE CONDITION
FAILS TO CLIMB DURING ALL COMPRESSION STROKES	STICKING VALVE IS INDICATED
20 LBS. BELOW NORMAL	FAULTY RINGS OR VALVE SEATING
MORE THAN 20 LBS. BELOW NORMAL IN TWO CYLINDERS NEXT TO EACH OTHER	FAULTY HEAD GASKET
20 LBS. ABOVE NORMAL	EXCESSIVE CARBON DEPOSIT BUILDUP

Figure 50. Compression Gauge Readings

Wet Compression Test

If faulty rings or valve seatings are indicated by a below normal gauge reading, additional steps are required to determine the exact cause.

1. Squirt approximately one tablespoon of heavy oil into the low cylinder.
2. Crank the engine to distribute the oil and then repeat the compression test.
 - a) If the readings show a considerable increase, the rings are worn. The increase in compression is due to the oil temporarily sealing the extra space between the piston ring and the cylinder wall.
 - b) If the readings remain approximately the same, the valves are stuck or are not seating correctly.

NOTE: Specifications, when available, may vary greatly depending upon barometric pressure, temperature and altitude. When all cylinders test within 75 percent of the highest reading and the compression results are still suspected of being unsatisfactory, compression results from a known good vehicle should be used for comparison.

Use of Engine Analyzer

The use of an engine analyzer (Fig. 51) can be beneficial to the technician. With an engine analyzer, the technician can perform numerous engine diagnostic tests. This video reference book explains how to perform an engine cranking test and gives the results from these tests. This will inform the technician if there is a problem with one or more of the cylinders.

Cranking Test

During the cranking test, each cylinder is compared with all other cylinders. The best cylinder will be given the value of "100." The engine analyzer then converts the value of the other cylinders to a percent of the best cylinder.

- **Faulty Cylinder Compression**—In Figure 52, the analyzer shows that one cylinder is not within 25 percent of the best cylinder. Figure 53 shows the results if two or more adjacent cylinders are not within 25 percent of the best cylinder. To find out the exact cause of either of these faults, it will be necessary to perform a compression test (both wet and dry) with an engine compression tester.

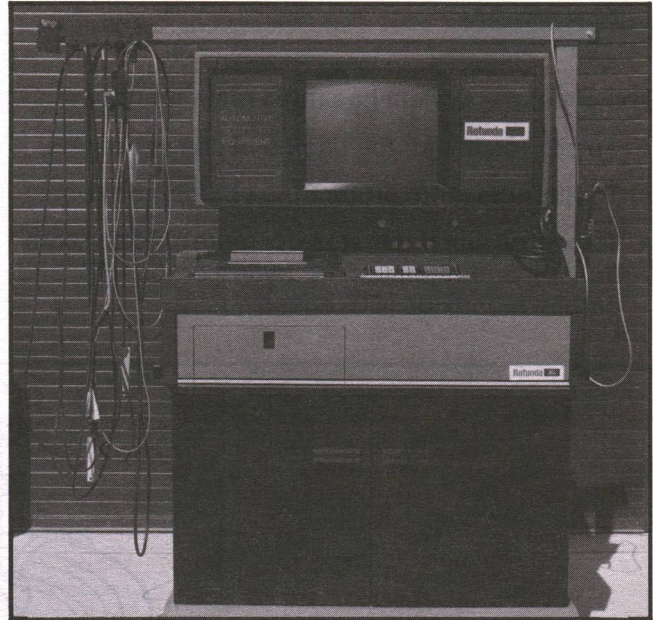


Figure 51. Rotunda Engine Analyzer Model No. 010-00400

CRANKING TEST								
CYL #	1	2	3	4	5	6	7	8
COMP. %	92	82	100	65	95	97	87	91
CRANKING VOLTS			10.69 VOLTS					
CRANKING CURRENT			207.0 AMP					
CRANKING VACUUM			2.0 INCHES					
CRANKING SPEED			166 RPM					
CRANKING DWELL			37.6 DEGREES					
COIL INPUT VOLTS			10.5 VOLTS					
HYDROCARBONS			93 PPM					
CRANK ENGINE TILL IT STARTS								

Figure 52. Cranking Test—Faulty Cylinder

CRANKING TEST								
CYL #	1	2	3	4	5	6	7	8
COMP. %	92	88	87	97	100	92	65	63
CRANKING VOLTS				10.69 VOLTS				
CRANKING CURRENT				207.0 AMP				
CRANKING VACUUM				2.0 INCHES				
CRANKING SPEED				166 RPM				
CRANKING DWELL				37.6 DEGREES				
COIL INPUT VOLTS				10.5 VOLTS				
HYDROCARBONS				93 PPM				
CRANK ENGINE TILL IT STARTS								

Figure 53. Cranking Test—Two or More Faulty Cylinders

AIR INTAKE SYSTEM

OPERATION

The air intake system has three main functions:

- To provide the air the engine needs to operate
- To filter the air to protect the engine from wear
- To control air temperature for more efficient combustion and reduction of hydrocarbon (HC) and carbon monoxide (CO) emissions

FILTERING

Dirt and dust particles are removed from the intake air by the filter element located inside the air cleaner housing (Fig. 54).

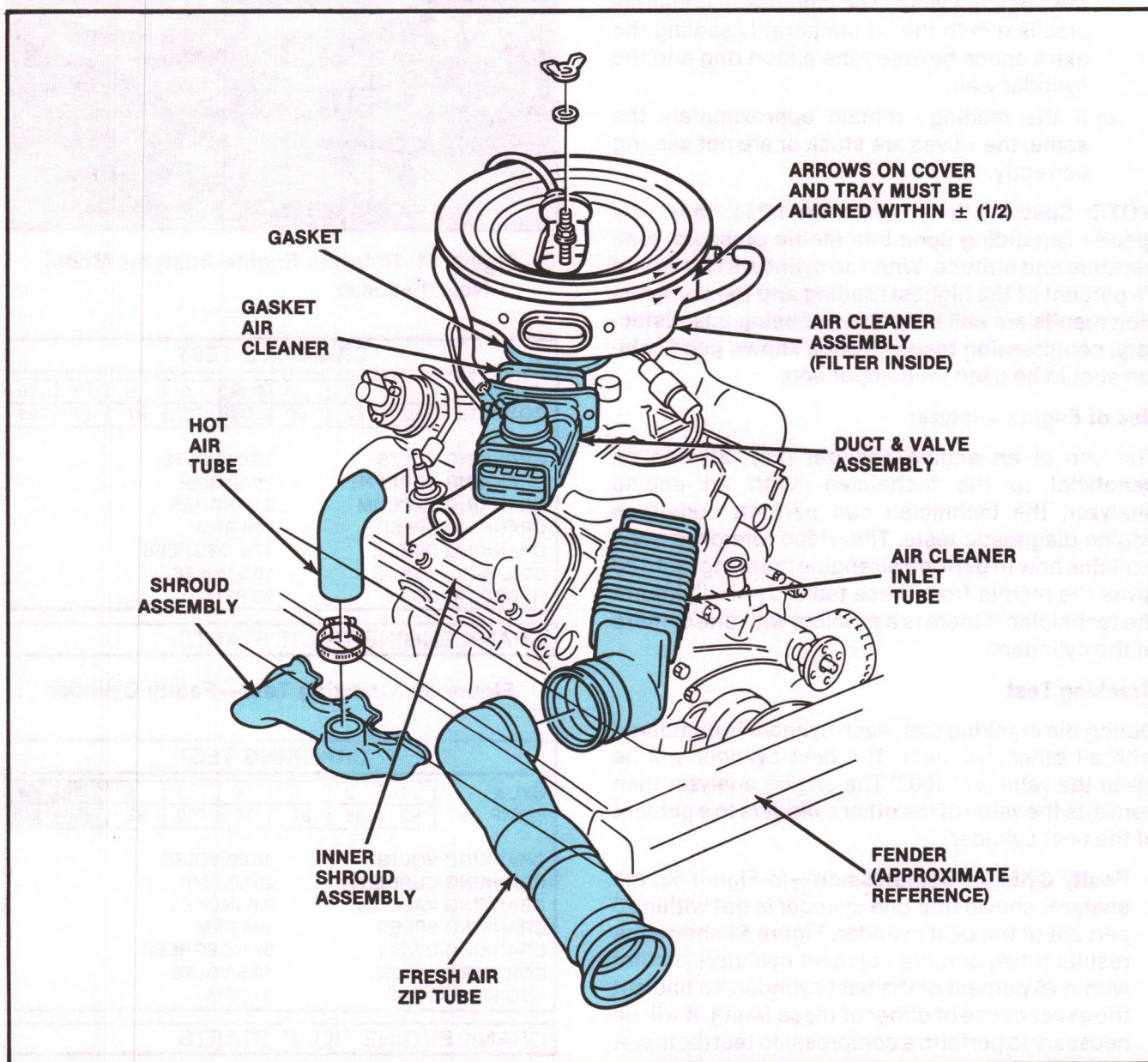


Figure 54. Typical Air Intake System

AIR TEMPERATURE CONTROL

Air temperature is controlled by the heated air intake system. The heated air intake system aids vaporization of the fuel on cold start-up by warming the intake air at the exhaust manifold. The air valve in the snorkel (cold air intake) should close off outside (ambient) air when a cold engine starts. At 24–41 °C (75–105 °F) in the air cleaner (depending on temperature setting of bimetal sensor), the bimetal sensor causes the air valve to open to outside air and shut off heated air (Fig. 55).

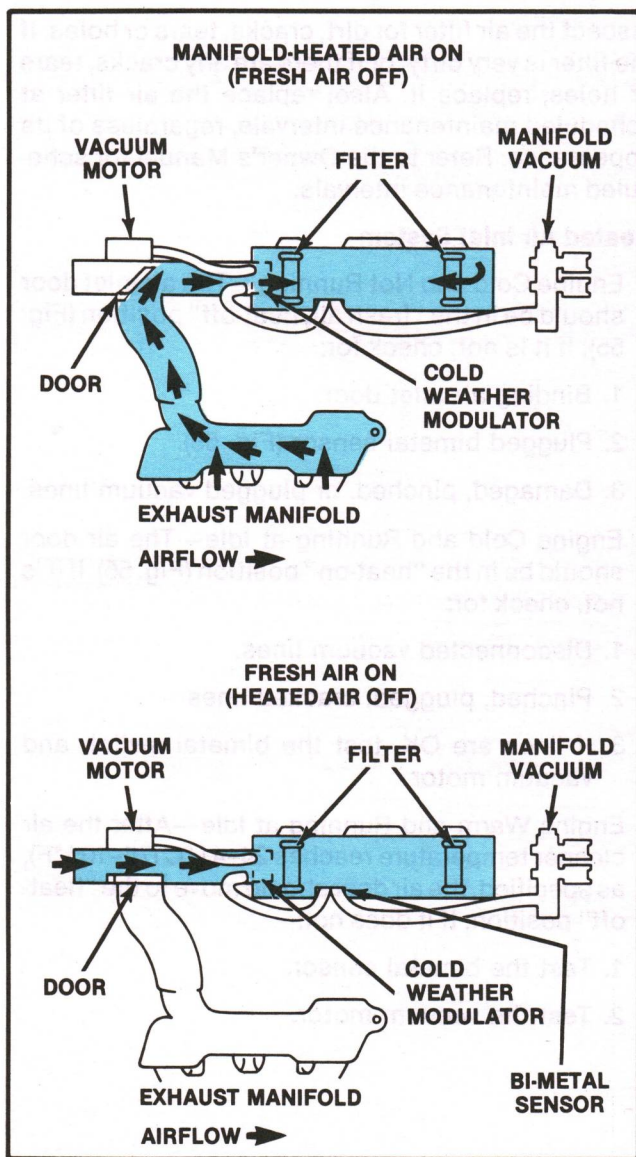


Figure 55. Heated Air Intake System Operation

AIR CLEANER VACUUM DOOR MOTOR OPERATION

When a vacuum signal is applied to the motor, it closes the door to cold air and allows warm air to enter the air cleaner. When a vacuum signal is not applied, the door opens to cold air.

AIR CLEANER BIMETAL TEMPERATURE SENSOR OPERATION

The bimetal sensor is installed in the air cleaner housing tray (Fig. 55). When the sensor is below a specified temperature, it allows a vacuum signal to flow through it to the air cleaner vacuum door motor. At a given increase in temperature, the sensor bleeds off vacuum, permitting the vacuum motor to open the duct door to allow fresh air to enter the engine.

COLD WEATHER MODULATOR OPERATION

The cold weather modulator is clipped to holes in the air cleaner housing assembly (Fig. 55) and senses the temperature of the inlet air. A bimetal disc actuates a check valve inside the modulator, depending on the air temperature.

- Open—the modulator passes vacuum freely either way.
- Closed—the modulator can (1) trap vacuum at an actuator or (2) block vacuum from being applied, depending on how the hoses are connected.

When the modulator is used to trap vacuum, it will trap the vacuum signal to the air cleaner vacuum door motor. This prevents the door from switching to cold inlet air when the vacuum drops during acceleration. After the engine warms up, there is no need to trap the vacuum to the door.

NOTE: Some applications use a vacuum retard delay valve (VRDV) instead of the cold weather modulator. The VRDV does the same job. Refer to Vacuum System Operation for information on the VRDV.

DRIVEABILITY SYMPTOMS AND MALFUNCTIONS

The following examples show how two common air intake system malfunctions can cause specific driveability symptoms.

AIR INTAKE SYSTEM

DIRTY AIR FILTER—POOR FUEL ECONOMY AND LACK OF POWER

If the air filter becomes very dirty, the dirt in it will partially block the flow of air into the fuel charging assembly (Fig. 56). Without enough air, the engine will constantly burn a rich air/fuel mixture, using up more fuel than it normally would. The use of extra fuel means poor fuel economy and the reduced air-flow can cause lack of power.

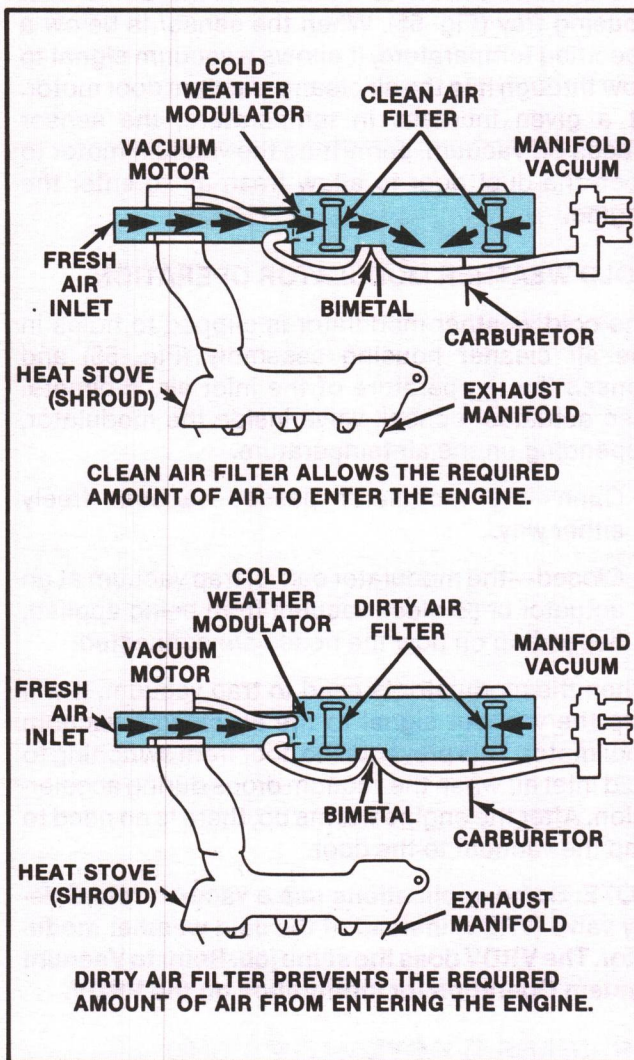


Figure 56. Restricted Airflow—Dirty Air Filter

HEATED AIR INLET DOOR STICKS OPEN—LACK OF POWER AND POOR FUEL ECONOMY

If the heated air inlet door sticks open, heated air cannot reach the engine, even if it is cold (Fig. 55). The cold air that does enter the engine will not allow the fuel to vaporize completely. Liquid fuel will not ignite as easily as fuel that is vaporized.

DIAGNOSIS

INSPECTION

Air Filter

Inspect the air filter for dirt, cracks, tears or holes. If the filter is very dirty, or if there are any cracks, tears or holes, replace it. Also, replace the air filter at scheduled maintenance intervals, regardless of its appearance. Refer to the Owner's Manual for scheduled maintenance intervals.

Heated Air Inlet System

- **Engine Cold and Not Running**—The air inlet door should be in the "fresh air, heat-off" position (Fig. 55). If it is not, check for:
 1. Binding air inlet door.
 2. Plugged bimetal sensor (Fig. 55).
 3. Damaged, pinched, or plugged vacuum lines.
- **Engine Cold and Running at Idle**—The air door should be in the "heat-on" position (Fig. 55). If it is not, check for:
 1. Disconnected vacuum lines.
 2. Pinched, plugged, cracked lines.
 3. If lines are OK, test the bimetal switch and vacuum motor.
- **Engine Warm and Running at Idle**—After the air cleaner temperature reaches 24–41 °C (75–105 °F), as specified, the air door should move to the "heat-off" position. If it does not:
 1. Test the bimetal sensor.
 2. Test the vacuum motor.

AIR INTAKE SYSTEM

TESTING

Bimetal Sensor Test

NOTE: Refer to Figure 57.

1. Apply heat to the sensor until it is warm to the touch (41°C or 105°F).
2. Check the air door position. It should be in the "heat-off" position (Fig. 55).
 - a) If the door is not in the "heat-off" position, check for vacuum to and from the sensor. If vacuum is OK, replace the sensor.
 - b) If the sensor and vacuum are OK, test the motor.

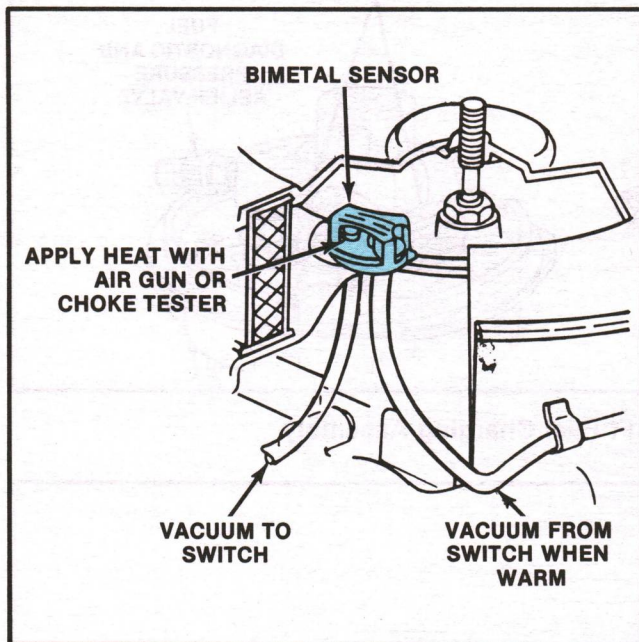


Figure 57. Bimetal Sensor Test

Vacuum Motor Test

NOTE: Refer to Figure 58.

1. Remove the vacuum hose at the motor.
2. Apply approximately 10–15 inches of vacuum to the motor with a vacuum pump.
 - a) The motor should hold vacuum.
 - b) The motor stem should pull the air door to the "heat-on" position (Fig. 55).

Replace the vacuum motor, if it does not operate properly. (If it does work OK, check and repair the vacuum source.)

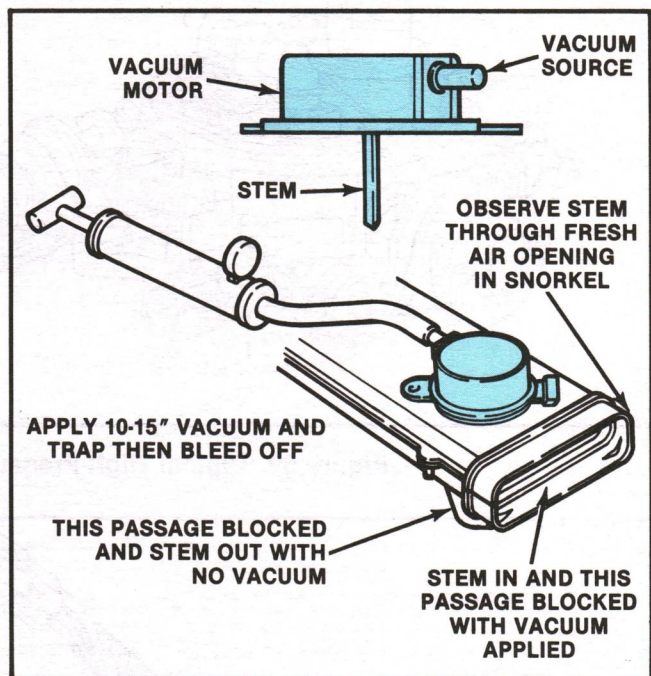


Figure 58. Vacuum Motor Test

FUEL SYSTEM

OPERATION

The Ford Motor Company produces two different versions of electronically controlled fuel injection systems for use in both automobiles and light trucks. These two systems are central fuel injection (CFI) and multi-point fuel injection (EFI). These systems are similar in operation.

- In a central fuel injection system the fuel is injected above the throttle plates(s).

- In a multi-point fuel injection (EFI) system, the fuel injectors are located in the lower intake manifold and direct fuel in front of each intake valve.

The CFI systems include a high-pressure system and a low-pressure system. In the high-pressure system, fuel is metered by two fuel injectors mounted on a fuel charging assembly that resembles a carburetor (Fig. 59). The low-pressure system uses one fuel injector mounted inside a fuel charging assembly (Fig. 60).

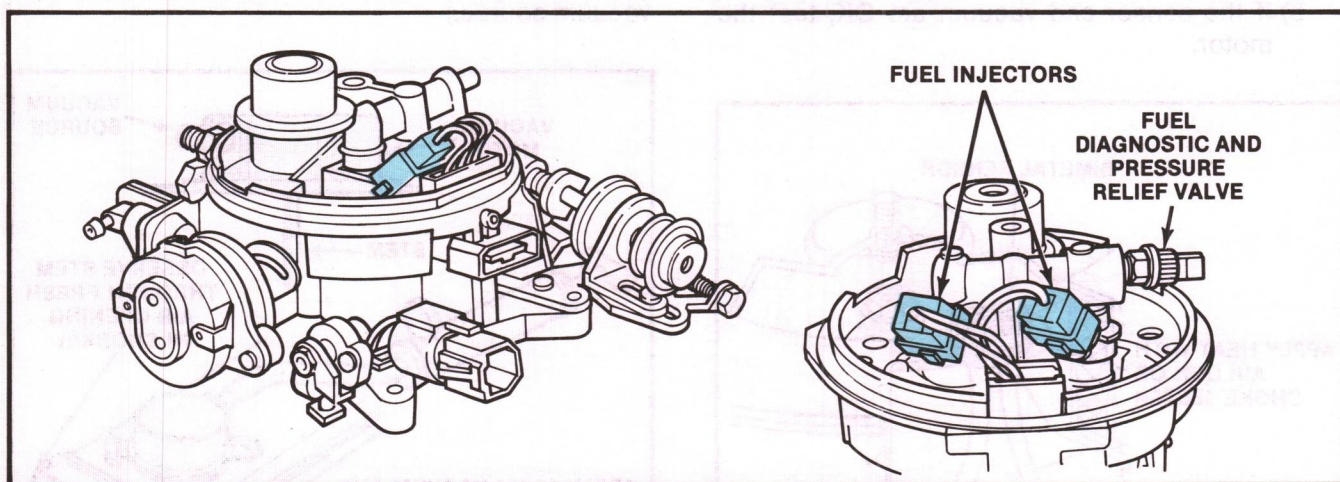


Figure 59. Typical High-Pressure CFI Fuel Charging Assembly

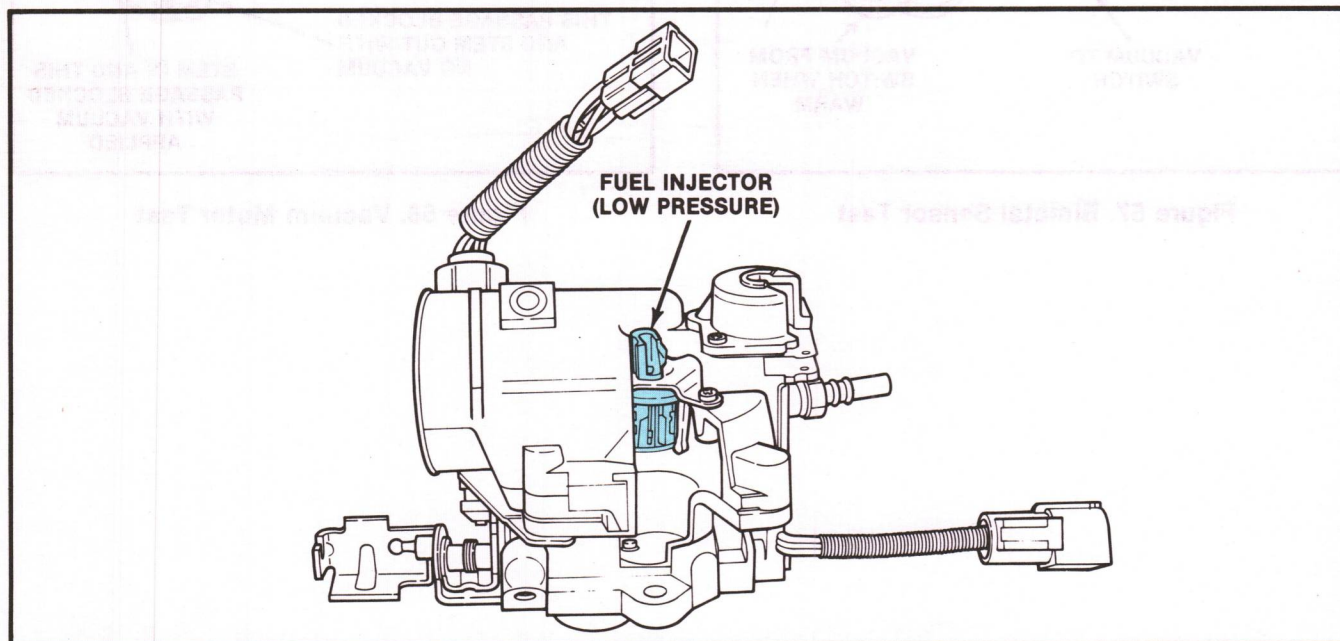


Figure 60. Typical Low-Pressure CFI Fuel Charging Assembly

The multi-point systems (EFI) use one injector for each cylinder. The injectors are mounted in the lower intake manifold. This manifold is part of a fuel charging manifold assembly comprised of a

throttle body, upper intake manifold assembly, lower intake manifold assembly and the fuel rail assembly (Fig. 61).

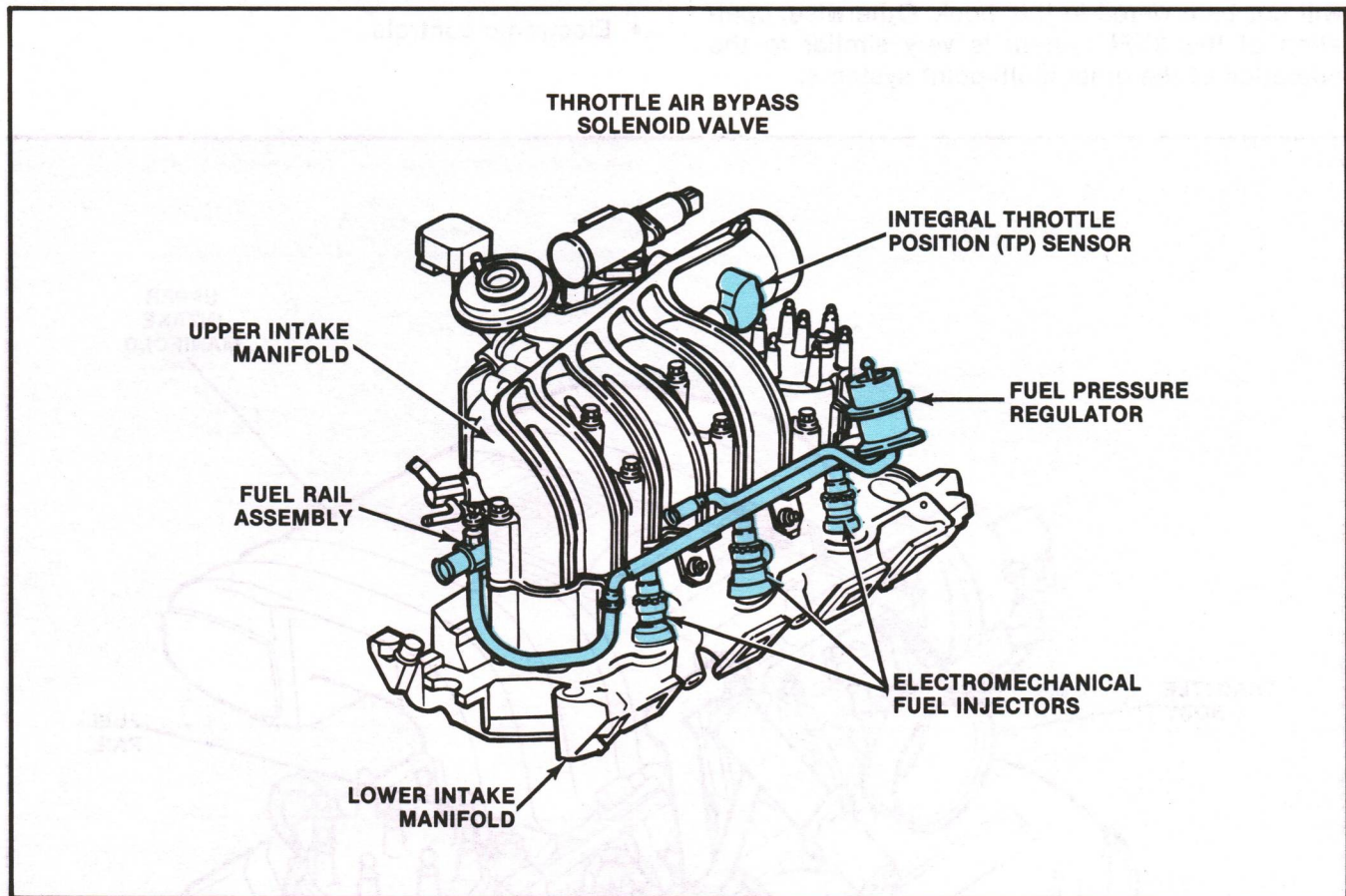


Figure 61. Typical Multi-Point (EFI) Fuel Charging Assembly

FUEL SYSTEM

A special type of multi-point system introduced recently is the sequential electronic fuel injection (SEFI) system (Fig. 62). The major difference between the SEFI and other multi-point systems (EFI) is in the electronic control of the injectors, which will not be covered in this book. Otherwise, operation of the SEFI system is very similar to the operation of the other multi-point systems.

All of the electronic fuel injection systems are composed of three subsystems:

- Air intake
- Fuel delivery
- Electronic controls

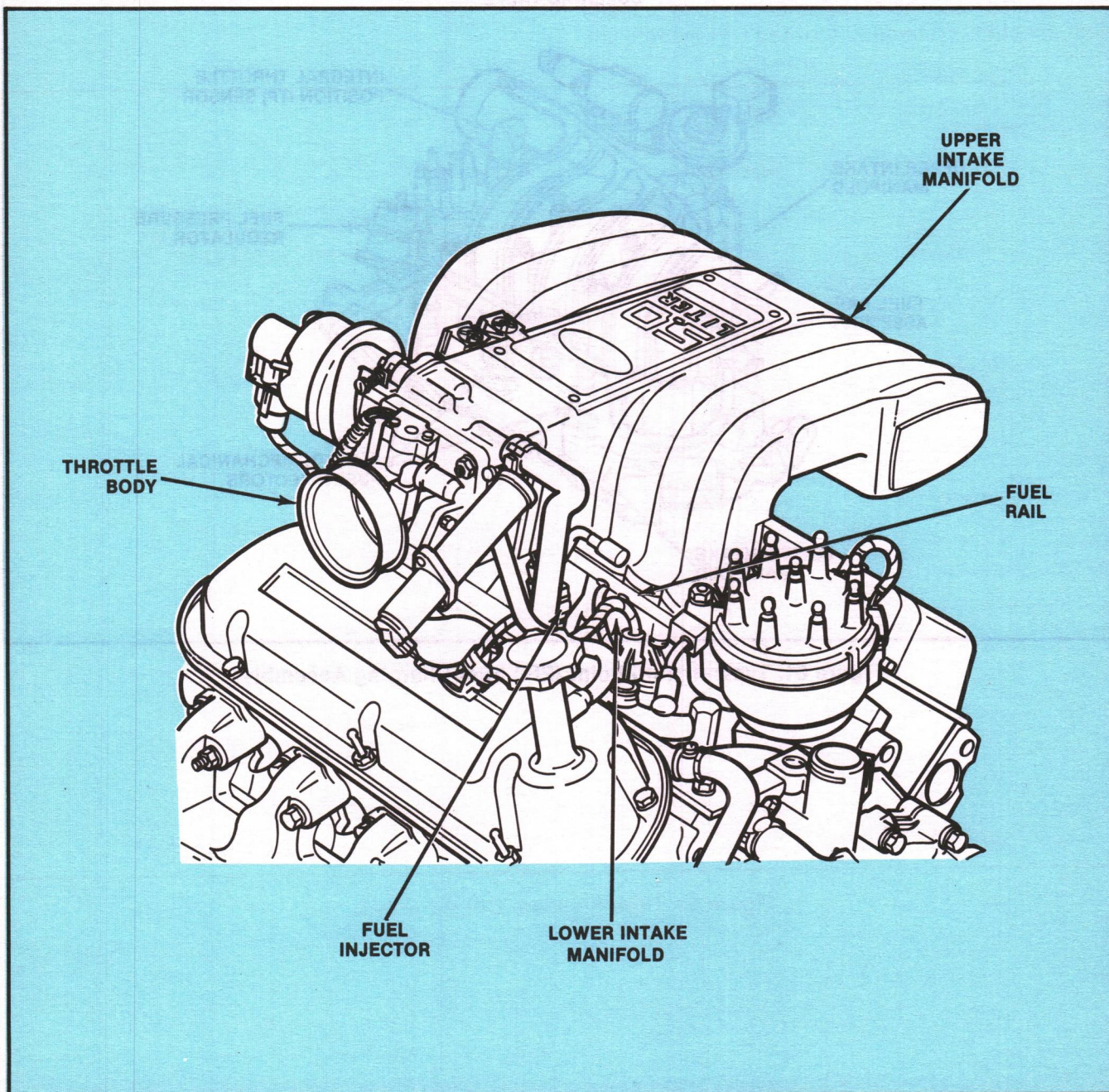


Figure 62. Sequential Electronic Fuel Injection (SEFI) System

AIR INTAKE

Air intake for the CFI systems is very much the same as on carbureted systems. When the throttle plate is opened, the outside air under normal atmospheric pressure is forced through the air horn because the pressure in the intake manifold is lower.

The primary difference between carburetion and fuel injection systems is that the CFI models use

injectors, controlled by a computer, to spray fuel into the engine.

Carburetors rely on intake manifold pressure, which is lower than atmospheric pressure, to draw fuel into the engine.

For the high-pressure CFI, (Fig. 63), two air horns are used that are very similar to the air horns on a carburetor.

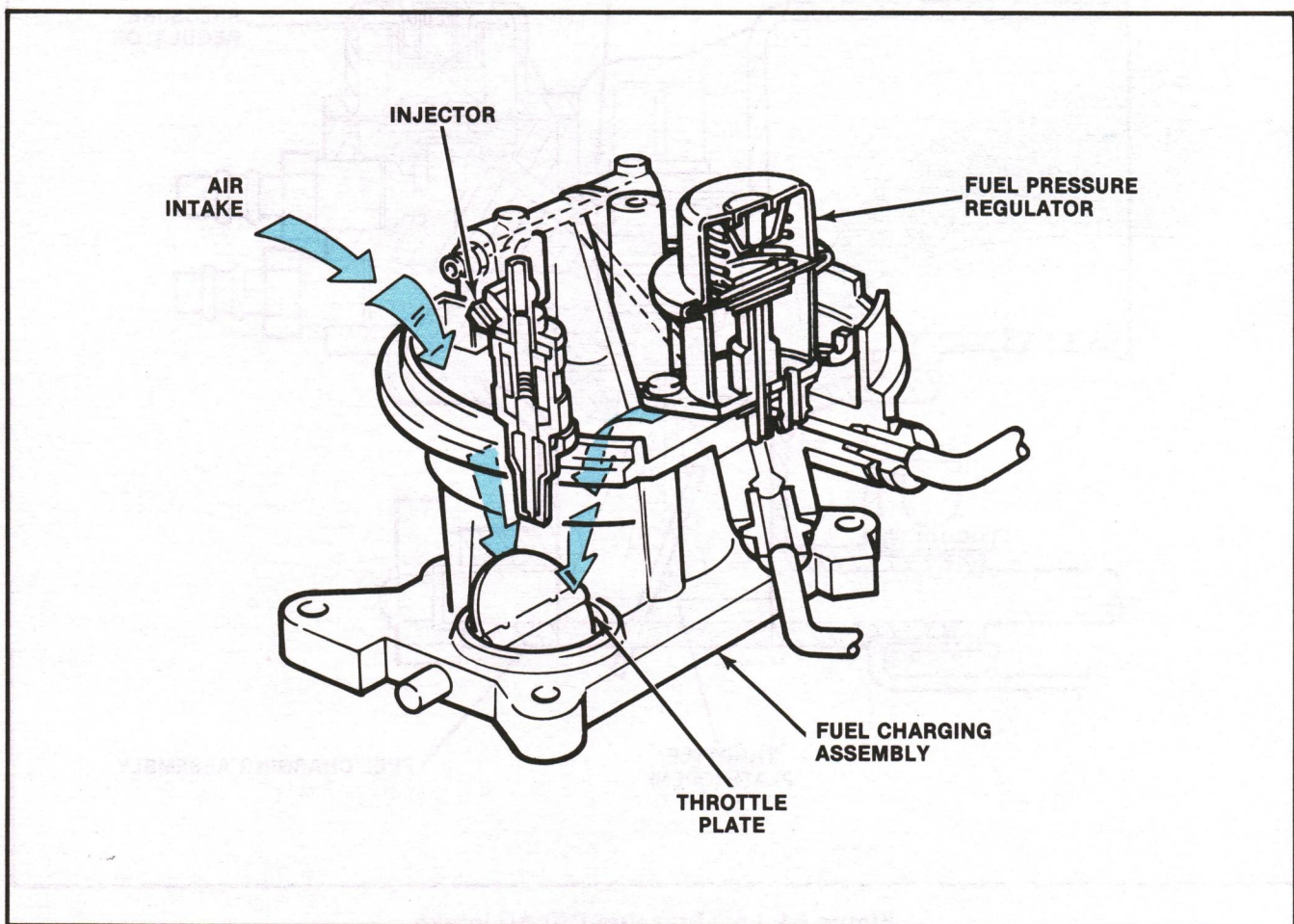


Figure 63. High-Pressure CFI Air Intake

FUEL SYSTEM

The low-pressure CFI air intake is on the side of the fuel charging assembly. Other than this, the air intake is the same as on the high-pressure system (Fig. 64).

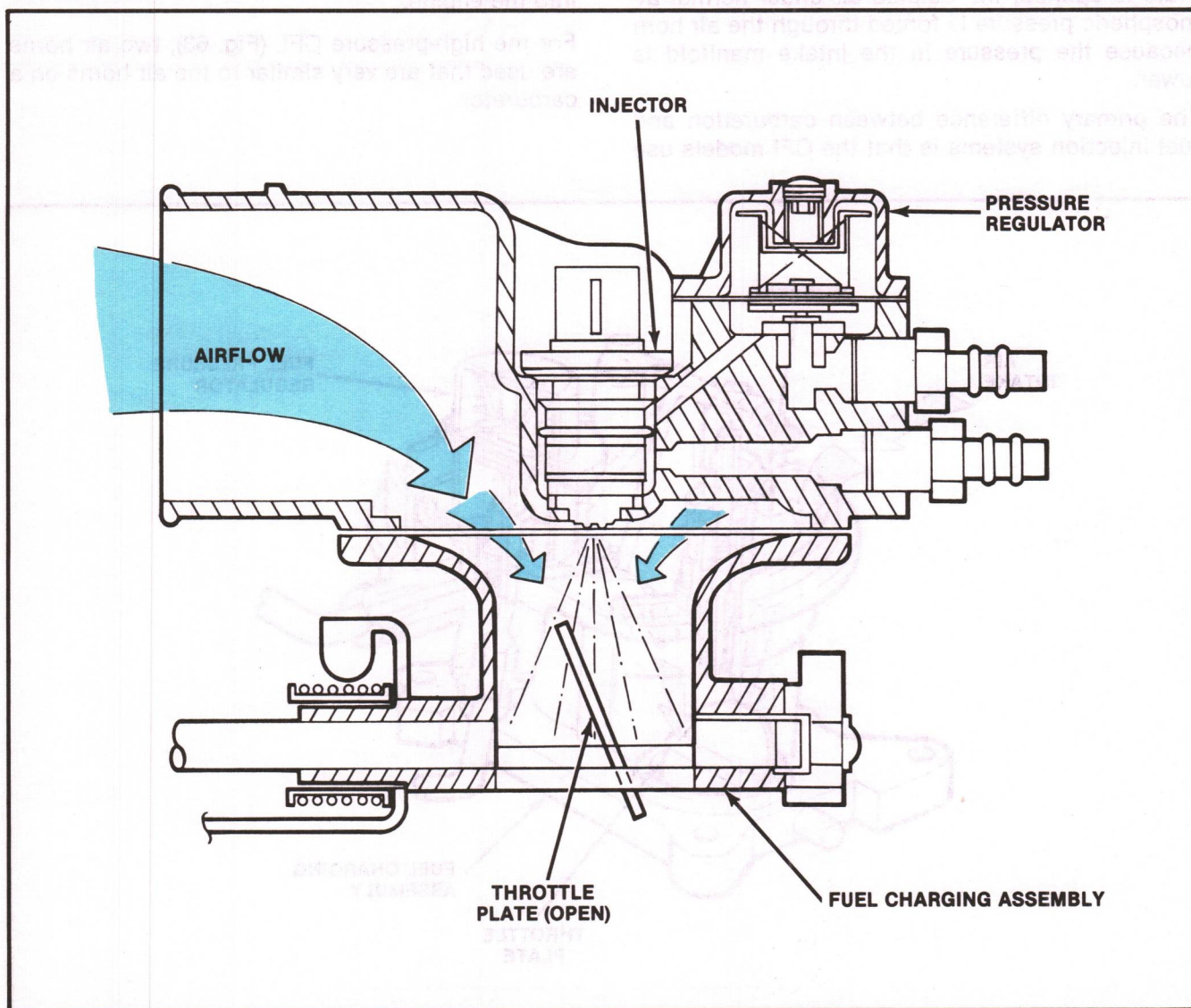


Figure 64. Low-Pressure CFI Air Intake

Air intake on the multi-point system is also through a throttle body. The throttle body, however, is horizontally mounted rather than vertically mounted as in the CFI systems (Fig. 65). An air bypass valve is located on top of the throttle body. This valve is used for idle-speed control.

AIR CONTROL

In both systems, air to the engine is controlled by a butterfly valve, or valves on some applications. The valve(s) is actuated by a linkage and pedal cable arrangement, operated by the driver, similar to the one used on carburetors.

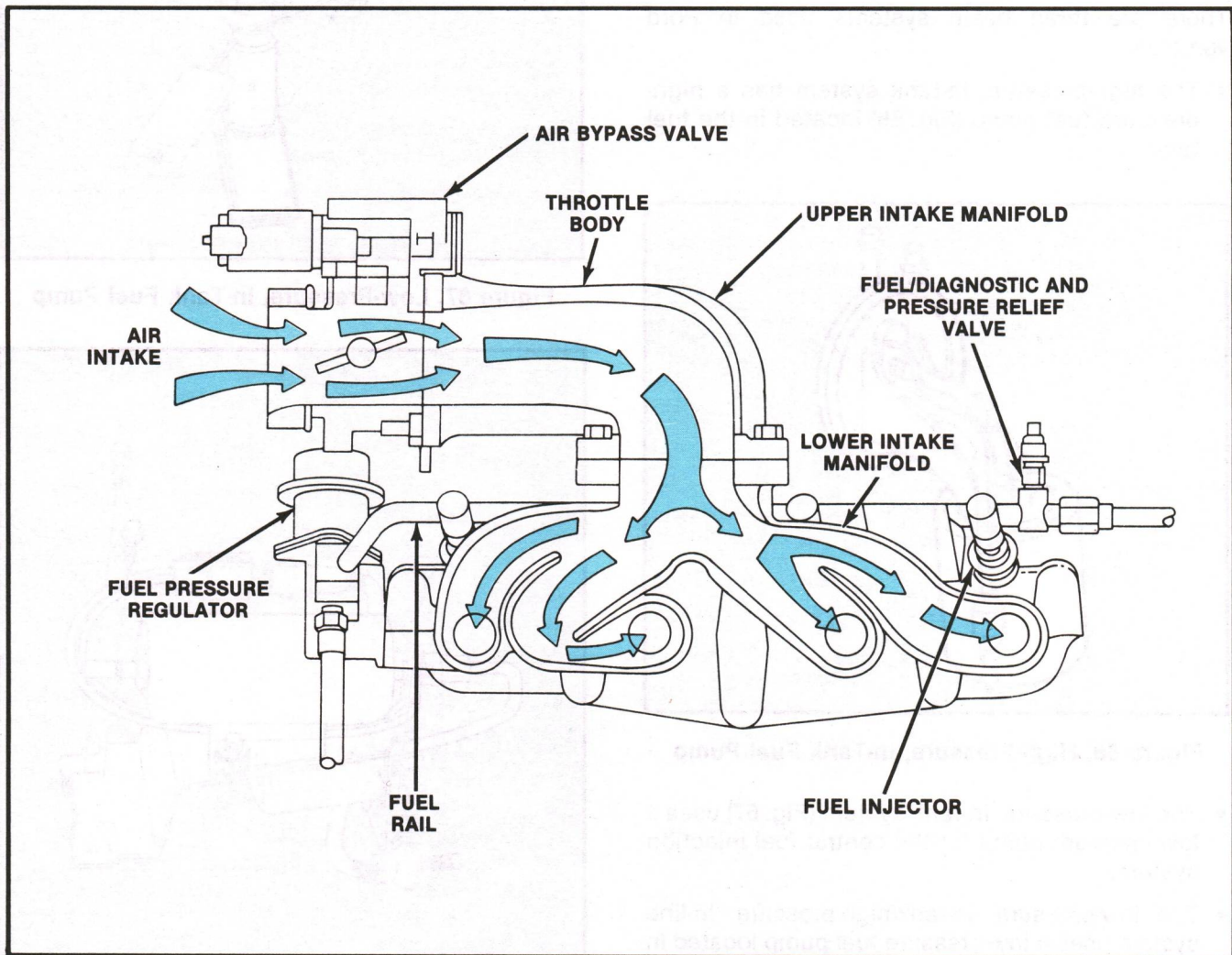


Figure 65. Multi-Point Fuel Injection Air Intake (Typical)

FUEL SYSTEM

FUEL DELIVERY

FUEL PUMPS

Fuel is delivered to the fuel injectors by way of an electric fuel pump or pumps, depending on vehicle application.

There are three basic systems used in Ford vehicles:

- The high-pressure, in-tank system has a high-pressure fuel pump (Fig. 66) located in the fuel tank.

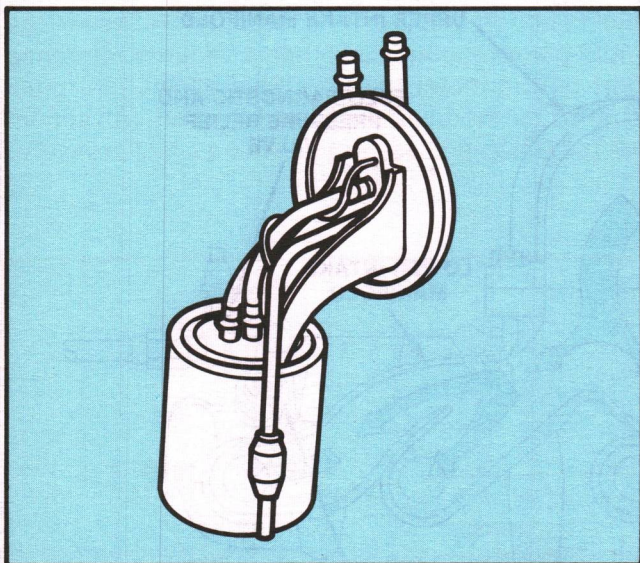


Figure 66. High-Pressure, In-Tank Fuel Pump

- The low-pressure, in-tank system (Fig. 67) uses a low-pressure pump for the central fuel injection system.
- The low-pressure, in-tank/high-pressure, in-line system uses a low-pressure fuel pump located in the fuel tank (Fig. 68) to supply fuel to the externally mounted, high-pressure pump. The high-pressure pump supplies the fuel to the injectors.

Refer to the Engine/Emissions Diagnosis Manual for fuel pump pressures.

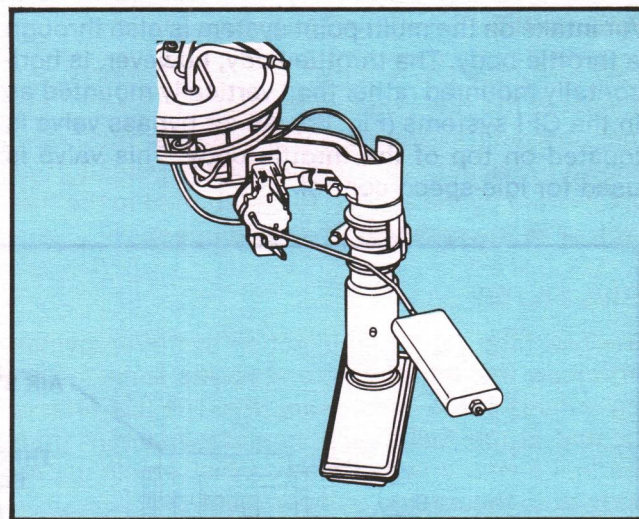


Figure 67. Low-Pressure, In-Tank Fuel Pump

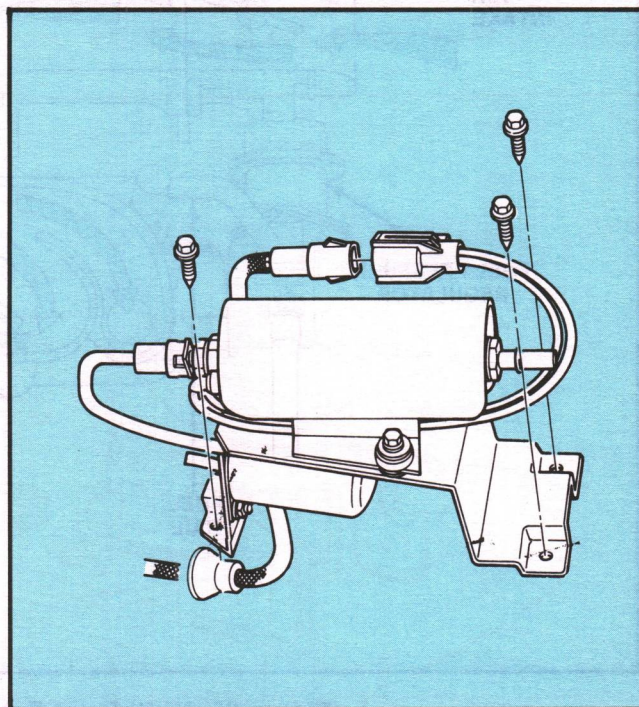


Figure 68. High-Pressure, In-Line Fuel Pump

FUEL LINES

Two fuel lines are required (Fig. 69). A supply line connects the fuel pump(s) through the filter to the fuel charging assembly or fuel rails. A return line allows excessive fuel supplied by the pump(s), but not needed by the engine, to be returned to the fuel tank or to the reservoir (if so equipped).

FUEL FILTER

The fuel filter for a fuel injection system provides extremely fine filtration to protect the small metering orifices of the injector nozzles. The fuel filter is located in the fuel supply line, downstream from the fuel pump. It is mounted on the vehicle underbody or in the engine compartment.

FUEL PRESSURE REGULATORS

A fuel pressure regulator is used to control the fuel pressure to the injectors. The fuel pressure regu-

lator is a hydromechanical device (a device where fluid pressure [hydro], in this case gasoline, overcomes spring pressure [mechanical] to move a diaphragm), that consists of a metal housing that has a fuel supply and return port.

Central fuel injection regulators (Fig. 70) contain a housing with a spring-loaded diaphragm that opens the valve and seat assembly to the return tube when the required fuel pressure is exceeded. This allows it to maintain a constant fuel pressure across the injectors.

The fuel pressure regulator (Fig. 70) for the multi-point (EFI) system operates similarly to the central fuel injection fuel pressure regulator. However, the multi-point regulator also has a vacuum reference port on the metal housing. This allows fuel pressure to be modulated by intake manifold vacuum (or turbo boost pressure) as well as fuel pressure.

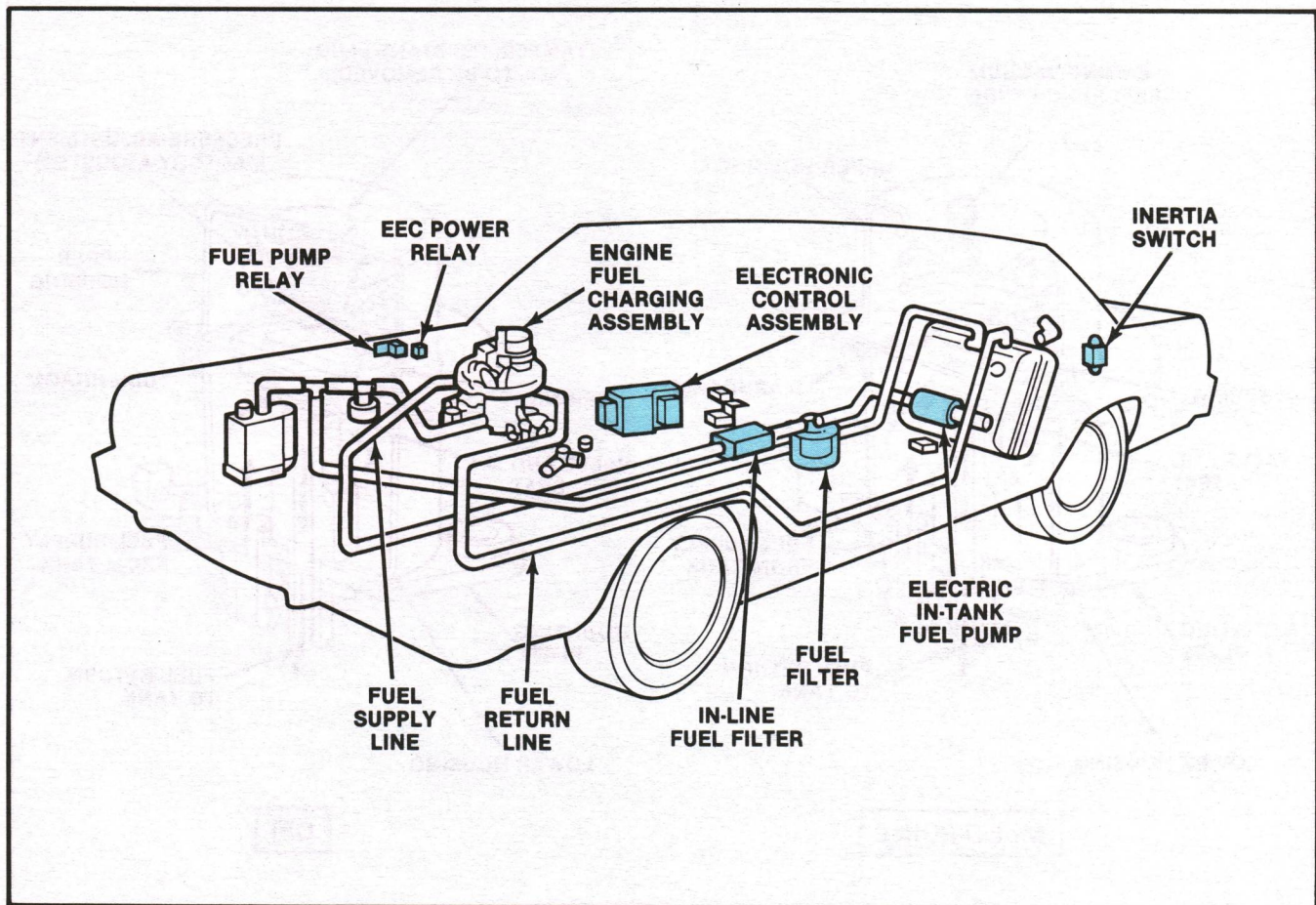


Figure 69. Typical CFI Fuel System

FUEL SYSTEM

The regulator not only regulates the fuel pressure, but also traps fuel during engine shutdown, eliminating the possibility of vapor formation in the fuel line and providing for instant restarts and initial idle speed. It also provides for a regulated 276 kPa (40 psi) pressure drop across the injectors and excessive fuel not required by the engine is returned to the fuel tank by way of a fuel return line.

DRIVEABILITY SYMPTOMS AND MALFUNCTIONS

The following three examples show how common fuel system malfunctions can cause specific driveability symptoms.

PLUGGED FUEL FILTER—CRANKS NORMALLY, BUT WON'T START OR STARTS NORMALLY, BUT WON'T RUN

If the fuel filter is completely plugged, no fuel will reach the injectors and the engine will not start. If the fuel filter is not totally plugged, it could allow just enough fuel flow to start the engine, but not enough to keep it running.

FUEL PUMP DOES NOT PROVIDE ENOUGH PRESSURE—LACK OF POWER

If the fuel pump malfunctions and does not provide sufficient fuel pressure, enough fuel may still be available to keep the engine running. However, the reduced pressure will not provide the fuel flow needed in high-demand (load) conditions like acceleration or hill-climbing. Without the necessary fuel, the engine will lack power.

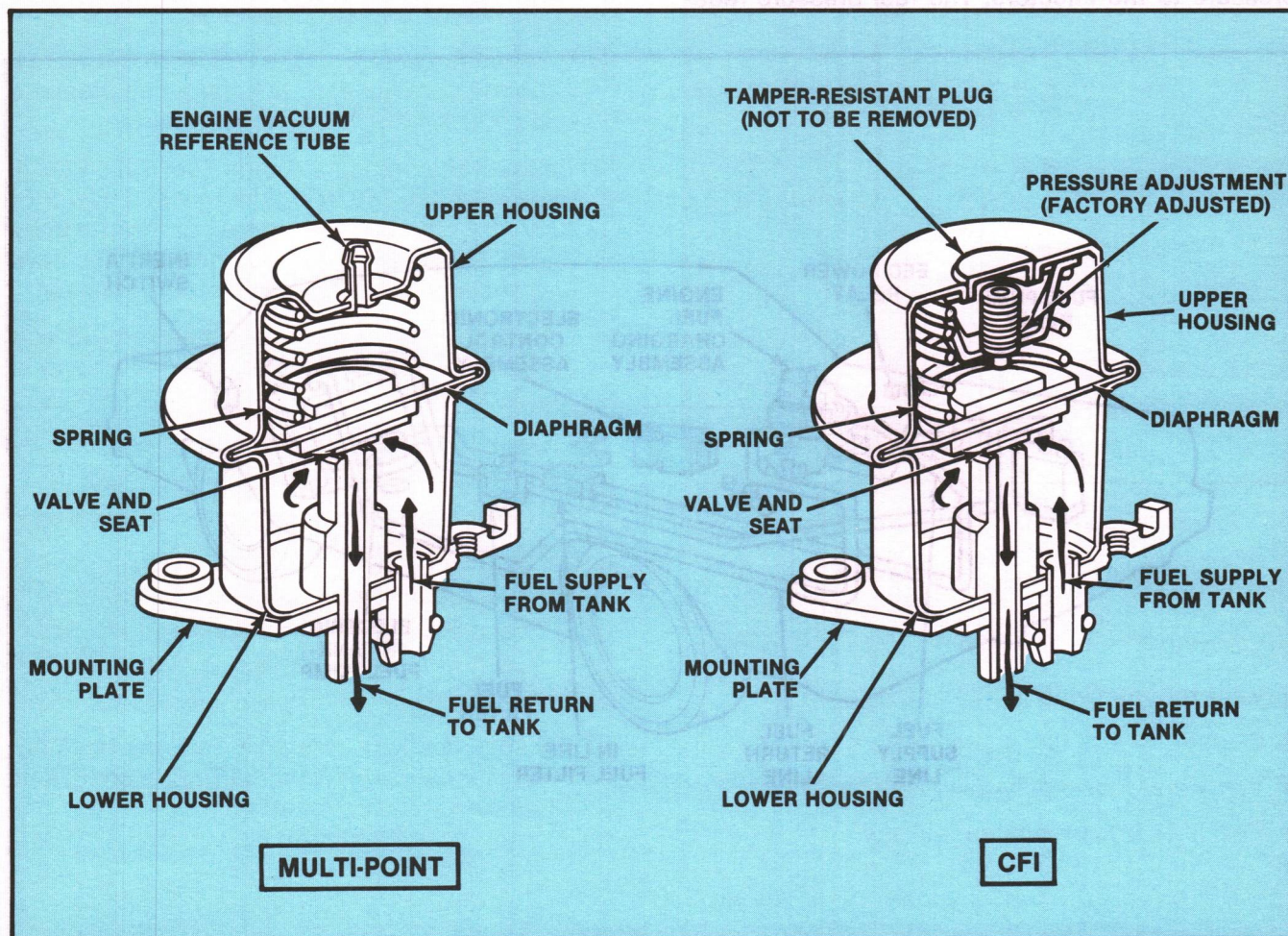


Figure 70. Fuel Pressure Regulators

LOOSE ELECTRICAL CONNECTOR TO FUEL INJECTOR SOLENOID—MISSES UNDER LOAD

The fuel injector solenoids (Fig. 71) control the entry of fuel into the engine, according to commands received from the electronic control assembly (ECA). If the electrical connector to one or more of the fuel injector solenoids are loose, the injector(s) will not fire when commanded to do so by the electronic control assembly (ECA). This will cause the engine to miss under a load condition. During an idle condition, the ECA will try to compensate for a misfiring injector or injectors.

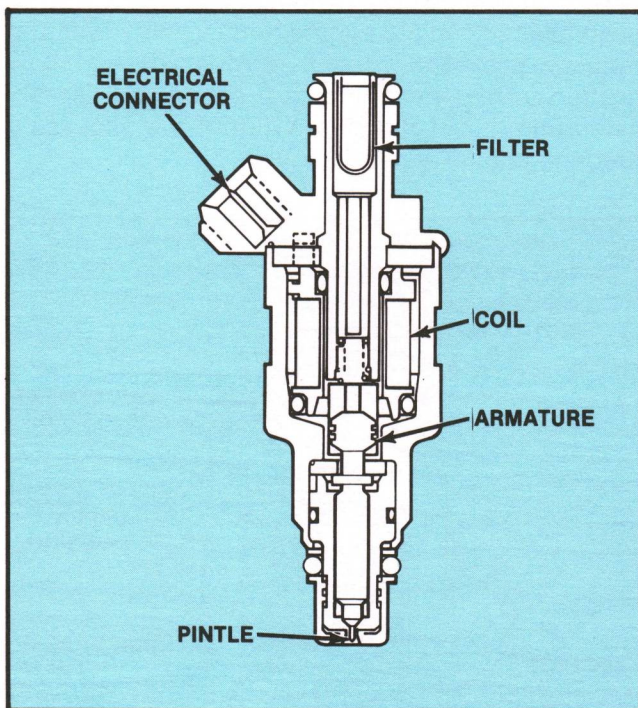


Figure 71. Typical Fuel Injector Solenoid

DIAGNOSIS

INSPECTION

Inspect the following points in the fuel system:

- Be sure there is fuel in the tank.
- Verify that fuel is of known good quality.
- Fuel lines and fittings for leakage.

- Intake manifolds, carburetor, or throttle body mountings for air leaks, cracks, or loose bolts.
- Fuel injector solenoids for loose or corroded connections to wiring harness.

TESTING

Fuel Pump Continuity

Check for electrical continuity at the fuel pump(s) as described in the Shop Manual.

Fuel System Pressure and Fuel Pump Output

NOTE: The following procedure contains the major steps required for all fuel-injected vehicles. Many models require additional steps. The fuel flow and pressure specifications vary from one model to the next. Refer to the Shop Manual for complete procedures and correct specifications.

1. Disconnect the fuel line at the fuel rail or throttle body. Use care to avoid spillage.
2. Connect the hose from the fuel return fitting to a calibrated container or at least a one liter (one quart) container.
3. Connect the Pressure Gauge Tool T80L-9974-A (or equivalent) to the fuel diagnostic valve (or Schrader valve) on the fuel rail or throttle body (Figs. 59 and 65). A few models do not have diagnostic valves. Refer to the Shop Manual.
4. Locate the fuel pump relay, then remove and replace it with the modified relay described in the Shop Manual.
5. Energize the fuel pump(s) for 10 seconds by grounding the ground lead from the relay.
6. Allow the fuel to drain from the hose into a container and observe the volume.
7. The fuel pump(s) are operating properly if:
 - a) Fuel pressure reaches a specified amount.
 - b) Fuel flow is at a specified amount.
 - c) Fuel pressure remains at a specified amount.

For specifications, refer to the appropriate Ford Shop Manual, Group 24 or the Engine/Emissions Diagnosis Manual, Volume H.

FUEL SYSTEM

8. If all three conditions are met, the fuel pump is operating normally.
9. If pressure condition is met but flow is not, check for blocked filter(s) and fuel supply lines. After correcting any blockage, recheck. If flow conditions are still not met, replace fuel pump.
10. If both pressure and flow conditions are met but pressure will not maintain after de-energizing, check for leakage at the regulator or the injectors. If both check OK, replace fuel pump.
11. If no flow or pressure is detected, the fuel system should be checked as in Step 1. If no trouble is found, replace the fuel pump, drop the fuel tank, and replace the fuel filter on the filler neck tube or on the low-pressure pump, depending on application.

EMISSION SYSTEMS

OPERATION

Gasoline is a mixture of chemical compounds that are called hydrocarbons. The term hydrocarbons is derived from the chemical formation of the various gasoline compounds, each of which is a chemical union of hydrogen (H) and carbon (C). In addition, the gasoline contains natural impurities as well as chemicals added by the gasoline refiner. All of these produce undesirable exhaust emissions.

During the combustion process, the carbon and hydrogen combine with oxygen, releasing heat energy and forming various chemical compounds. If the combustion was perfect, then the exhaust gases would consist only of carbon dioxide (CO_2) and water (H_2O), neither of which are considered harmful in the atmosphere.

Unfortunately, the combustion of the internal combustion engine is not perfect. In addition to the CO_2 , the exhaust gases contain carbon monoxide (CO), oxides of nitrogen (NO_x) (produced by a chemical union of nitrogen and oxygen), unburned hydrocarbons (HC), oxides of sulfur and other compounds. Since sulfur is contained in crude oil as it comes out of the ground, it became the responsibility of the refiner to remove sulfur prior to producing gasoline.

Improved engine designs, such as the high-swirl combustion (HSC) engine, along with electronic fuel injection, are helping to reduce exhaust emissions.

THERMACTOR AIR SYSTEM OPERATION

MANAGED THERMACTOR AIR SYSTEM

The managed Thermactor air system (Fig. 72) is used to reduce the amount of hydrocarbons (HC) and carbon monoxide (CO) in the exhaust system. The Thermactor system supplies additional air needed to minimize a problem inherent with internal combustion engines: that of incomplete combustion due to the isolation of the combustion chamber and the exhaust manifold from atmospheric oxygen.

Secondary air from the air pump introduces fresh air into the hot exhaust gases as they enter the exhaust manifold, cylinder head or catalytic converter. This air supplies oxygen to promote further burning, converting more of the emissions contained in the gases into harmless carbon dioxide (CO_2) and water (H_2O). Secondary air can also be used to help heat the EGO sensor and catalyst.

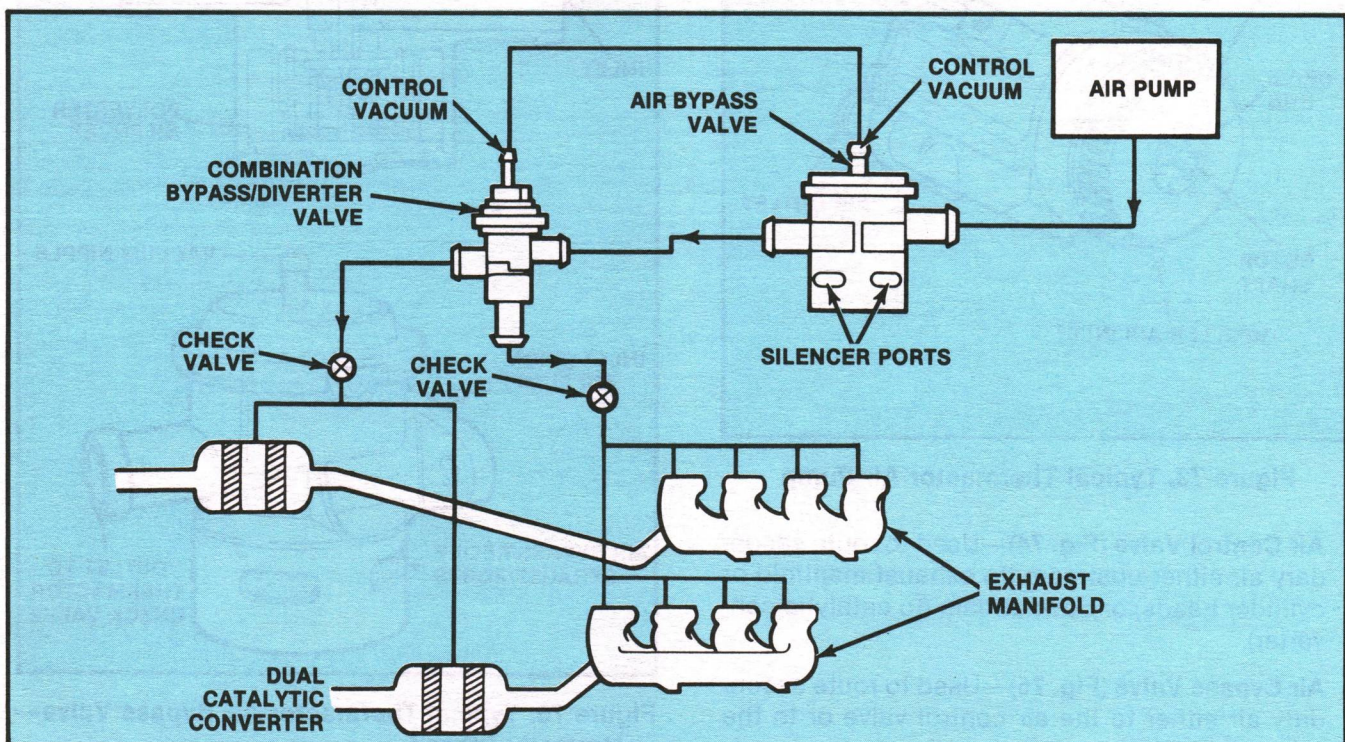


Figure 72. Typical Managed Thermactor Air System

EMISSION SYSTEMS

The Thermactor system operates with the following:

- **Air Pump (Fig. 73)**—Draws in fresh air and sends it to the air distribution manifold where it is directed to either the exhaust manifold, cylinder heads or catalytic converter.

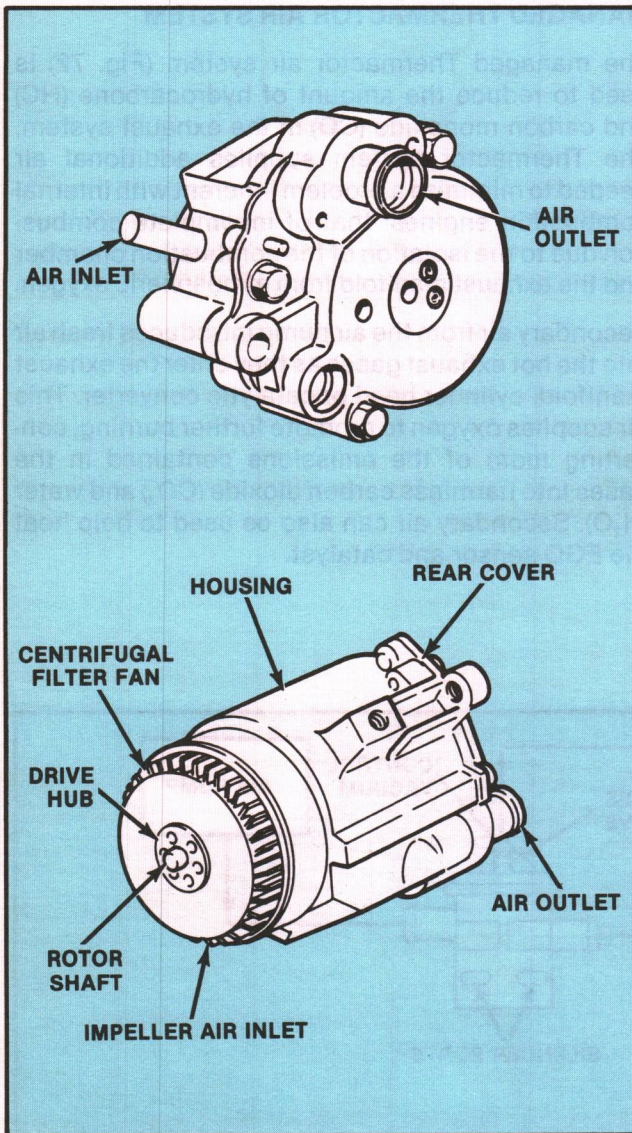


Figure 73. Typical Thermactor Air Pump

- **Air Control Valve (Fig. 74)**—Used to route secondary air either upstream (to exhaust manifold or cylinder heads) or downstream (to catalytic converter).
- **Air Bypass Valve (Fig. 75)**—Used to route secondary air either to the air control valve or to the atmosphere.

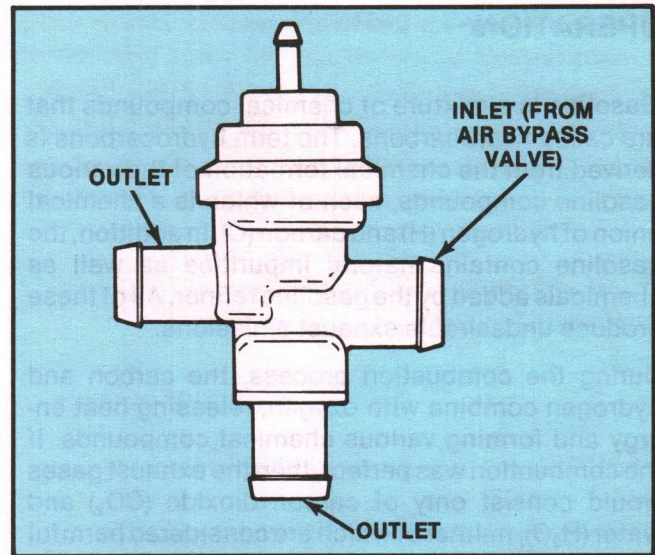


Figure 74. Typical Thermactor Air Control Valve

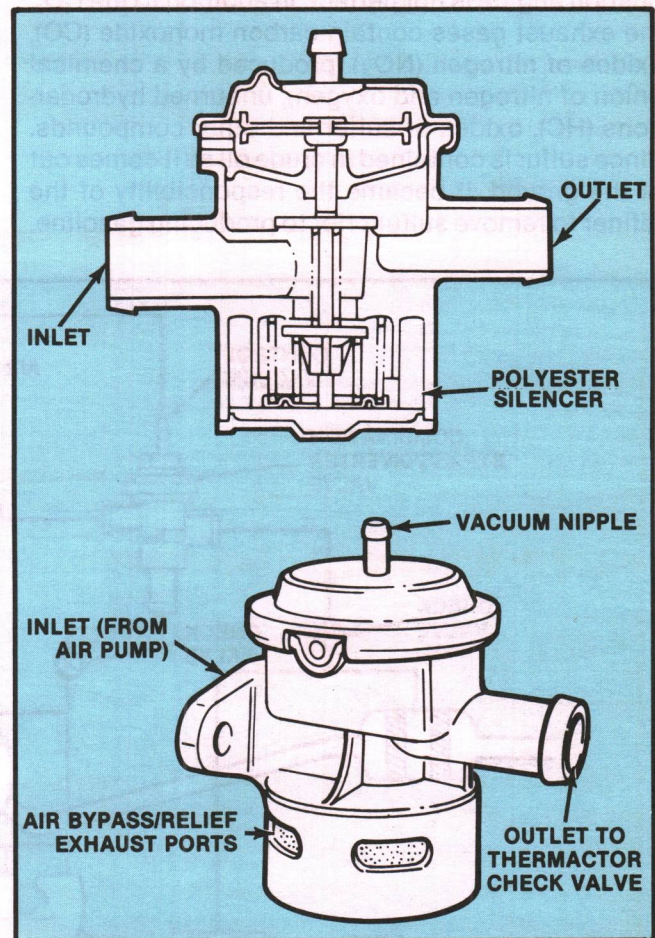


Figure 75. Typical Thermactor Air Bypass Valve—Normally Closed

- **Combination Air Control Valve (Fig. 76)**—A valve that combines the air control valve function of diverting Thermactor air upstream and downstream with the function of the air bypass valve.
- **Air Distribution Manifold**—Used to distribute Thermactor air to the exhaust manifold, cylinder head or catalytic converter.
- **Air Thermactor Check Valves (Fig. 77)**—Used to prevent exhaust from flowing back into the Thermactor air system.

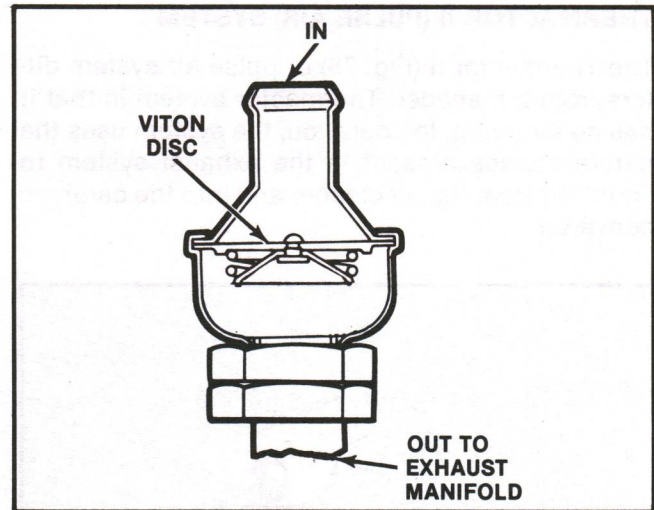


Figure 77. Typical Thermactor Air Check Valve

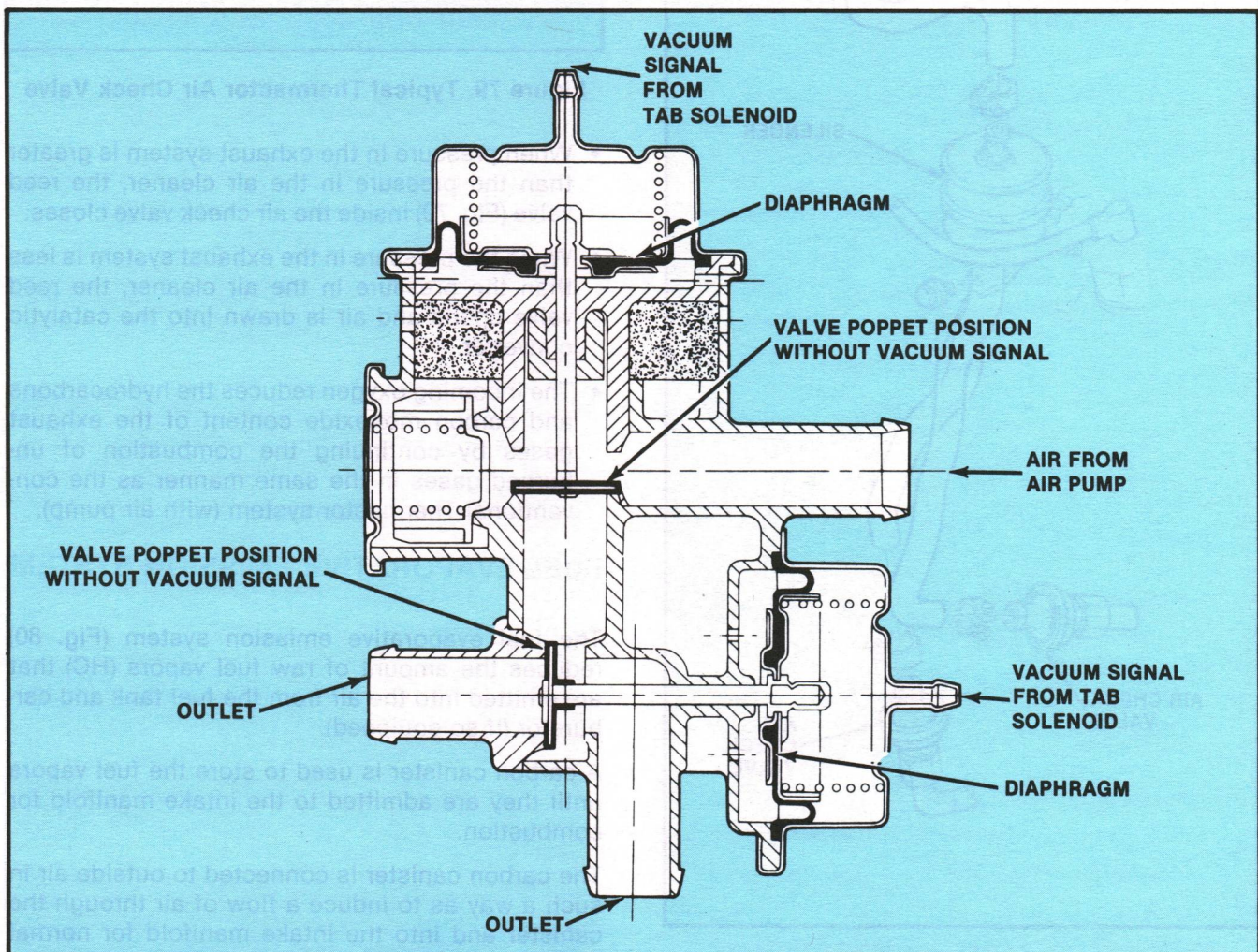


Figure 76. Combination Air Control Valve

EMISSION SYSTEMS

THERMACTOR II (PULSE AIR) SYSTEM

The Thermactor II (Fig. 78) or pulse air system differs from a managed Thermactor system in that it has no air pump. In operation, the system uses the natural pulses present in the exhaust system to "pull" air from the air cleaner and into the catalytic converter.

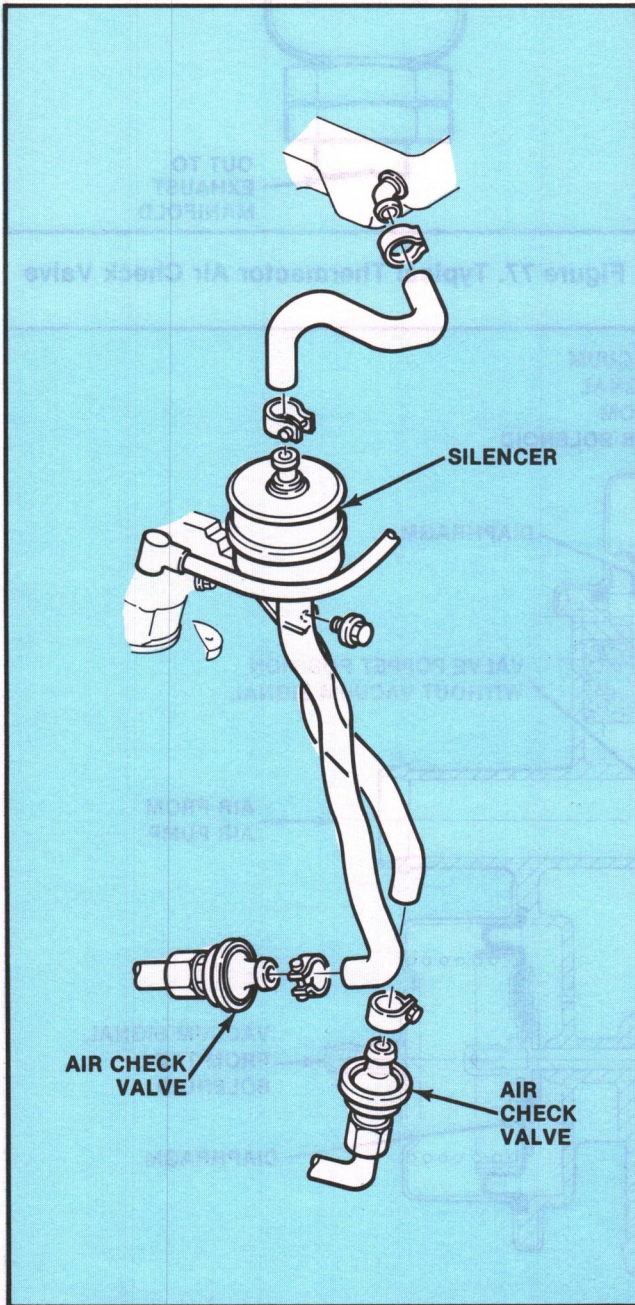


Figure 78. Typical Thermactor II or Pulse Air System

- An air check valve and silencer (Fig. 78) are connected in-line between the air cleaner and the catalytic converter.

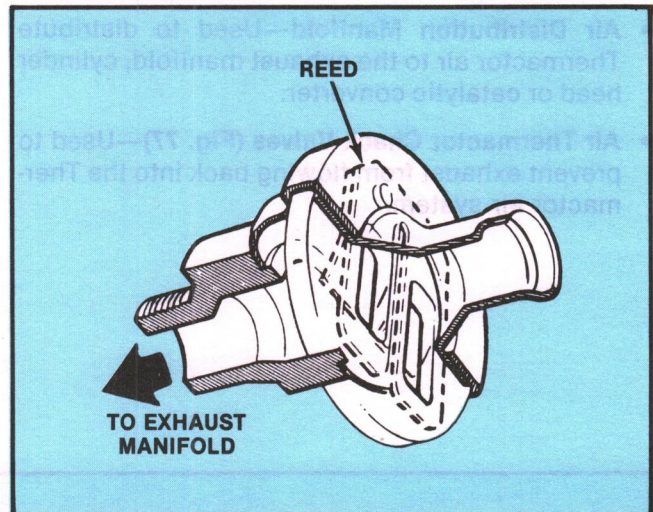


Figure 79. Typical Thermactor Air Check Valve

- When pressure in the exhaust system is greater than the pressure in the air cleaner, the reed valve (Fig. 79) inside the air check valve closes.
- When the pressure in the exhaust system is less than the pressure in the air cleaner, the reed valve opens and air is drawn into the catalytic converter.
- The incoming oxygen reduces the hydrocarbons and carbon monoxide content of the exhaust gases by continuing the combustion of unburned gases in the same manner as the conventional Thermactor system (with air pump).

FUEL EVAPORATIVE EMISSION SYSTEM

The fuel evaporative emission system (Fig. 80) reduces the amount of raw fuel vapors (HC) that are emitted into the air from the fuel tank and carburetor (if so equipped).

A carbon canister is used to store the fuel vapors until they are admitted to the intake manifold for combustion.

The carbon canister is connected to outside air in such a way as to induce a flow of air through the canister and into the intake manifold for normal combustion during engine operation. This action purges the canister of stored fuel vapors.

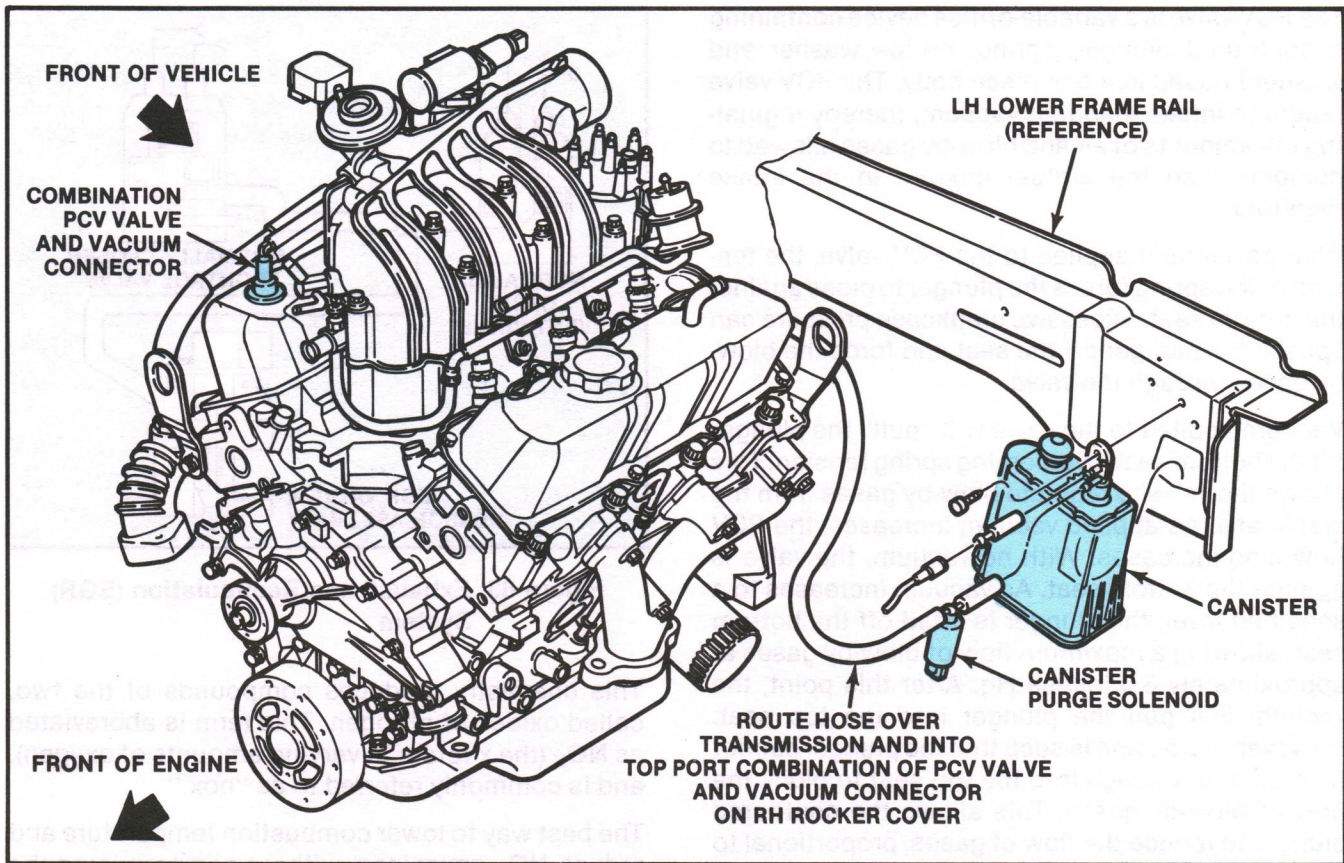


Figure 80. Typical Fuel Evaporative Emissions System—3.0L Taurus/Sable

POSITIVE CRANKCASE VENTILATION SYSTEM

To reduce the amounts of hydrocarbon (HC) emissions that emit from the crankcase of the engine, all cars are equipped with a positive crankcase ventilation (PCV) system (Fig. 81).

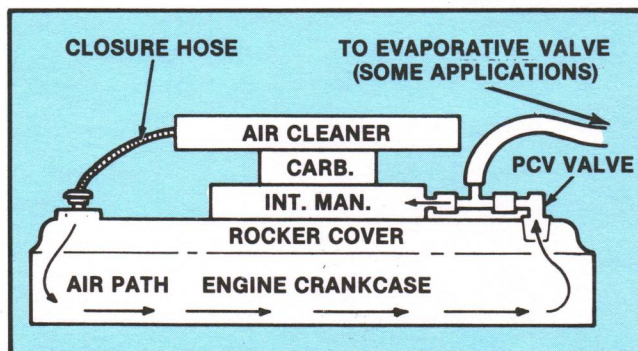


Figure 81. Typical Positive Crankcase Ventilation (PCV) System

The PCV system controls the amount of blow-by vapors from the crankcase and into the intake manifold by way of a PCV valve (Fig. 82).

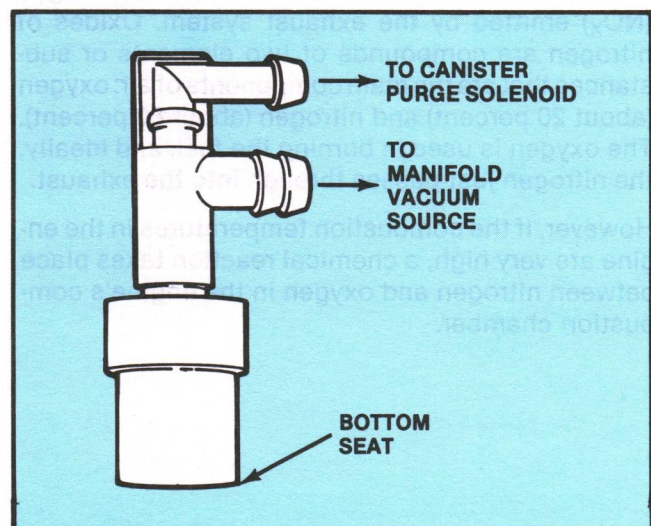


Figure 82. Typical PCV Valve

EMISSION SYSTEMS

The PCV valve is a variable-orifice device containing a contoured plunger, spring, orifice washer and washer housed in a one-piece body. The PCV valve reacts to intake manifold vacuum, thereby regulating the amounts of air and blow-by gases allowed to combine with the air/fuel mixture in the intake manifold.

With no vacuum applied to the PCV valve, the tension of the spring forces the plunger to close against the bottom seat. Excessive crankcase pressure can “push” the plunger off the seat and force the blow-by gases through the valve.

Vacuum applied to the valve will “pull” the plunger off the bottom seat, overcoming spring tension. This allows the valve to regulate blow-by gases from the crankcase. As applied vacuum increases, the PCV flow also increases. With no vacuum, the valve is against the bottom seat. As vacuum increases to a specified level, the plunger is lifted off the bottom seat, allowing a maximum flow of blow-by gases at approximately 3.0 inches Hg. After this point, the vacuum will pull the plunger into the top seat. However, the design is such that the plunger cannot be pulled far enough into the top seat to block the flow of blow-by gases. This allows the contoured plunger to reduce the flow of gases, proportional to the opening allowed by the size of the top seat to the contour of the plunger.

EGR SYSTEM

The exhaust gas recirculation (EGR) system (Fig. 83) is used to reduce the amount of oxides of nitrogen (NO_x) emitted by the exhaust system. Oxides of nitrogen are compounds of two elements or substances that are the main components of air: oxygen (about 20 percent) and nitrogen (about 80 percent). The oxygen is used in burning the fuel, and ideally, the nitrogen just passes through into the exhaust.

However, if the combustion temperatures in the engine are very high, a chemical reaction takes place between nitrogen and oxygen in the engine's combustion chamber.

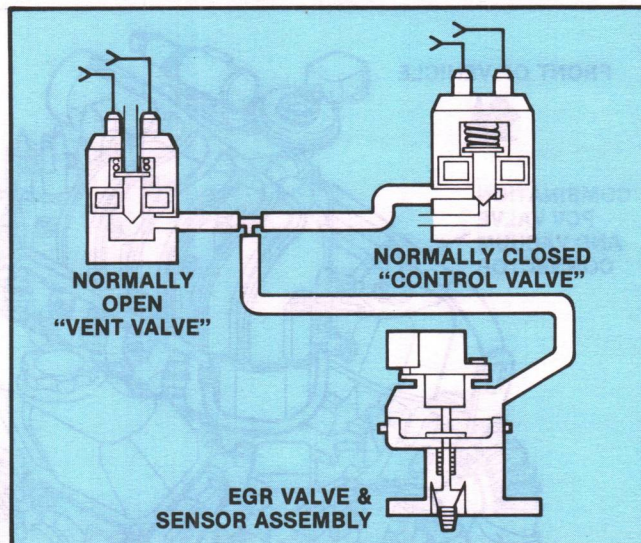


Figure 83. Exhaust Gas Recirculation (EGR) System

This chemistry produces compounds of the two, called oxides of nitrogen. This term is abbreviated as NO_x (the x refers to varying amounts of oxygen), and is commonly referred to as “nox.”

The best way to lower combustion temperature and reduce NO_x emissions, without compromising the engine's fuel economy and performance, is to recirculate exhaust gases back into the combustion chamber.

An EGR valve (Figs. 84, 85 and 86) is used to feed some of the spent exhaust gas back through the cylinders to reduce the combustion temperatures.

The EGR valve is controlled by a vacuum signal. As vacuum is applied to the EGR valve, it opens proportionately to allow exhaust gas to flow into the intake manifold.



Figure 84. Typical Positive Crankcase Ventilation (PCV) System

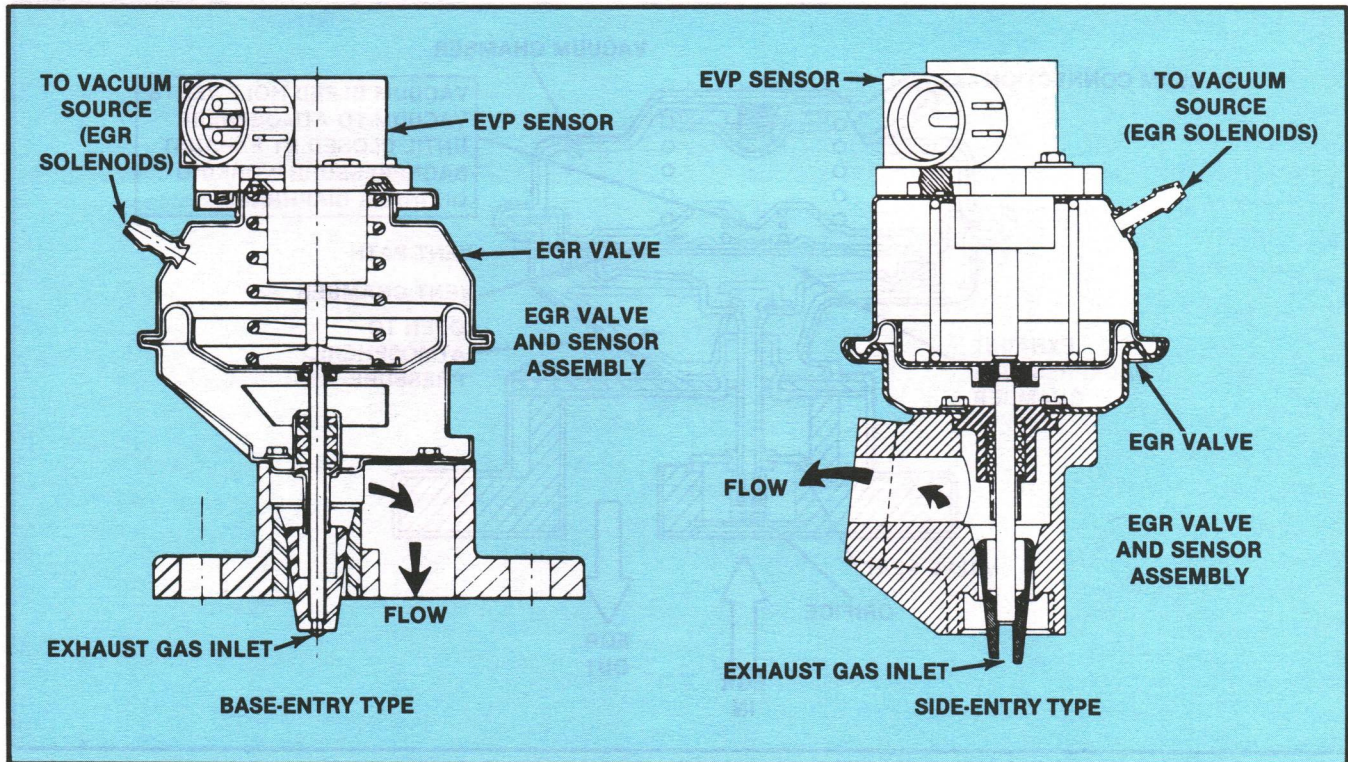


Figure 84. Typical Electronic EGR Valves—Base- and Side-Entry Types

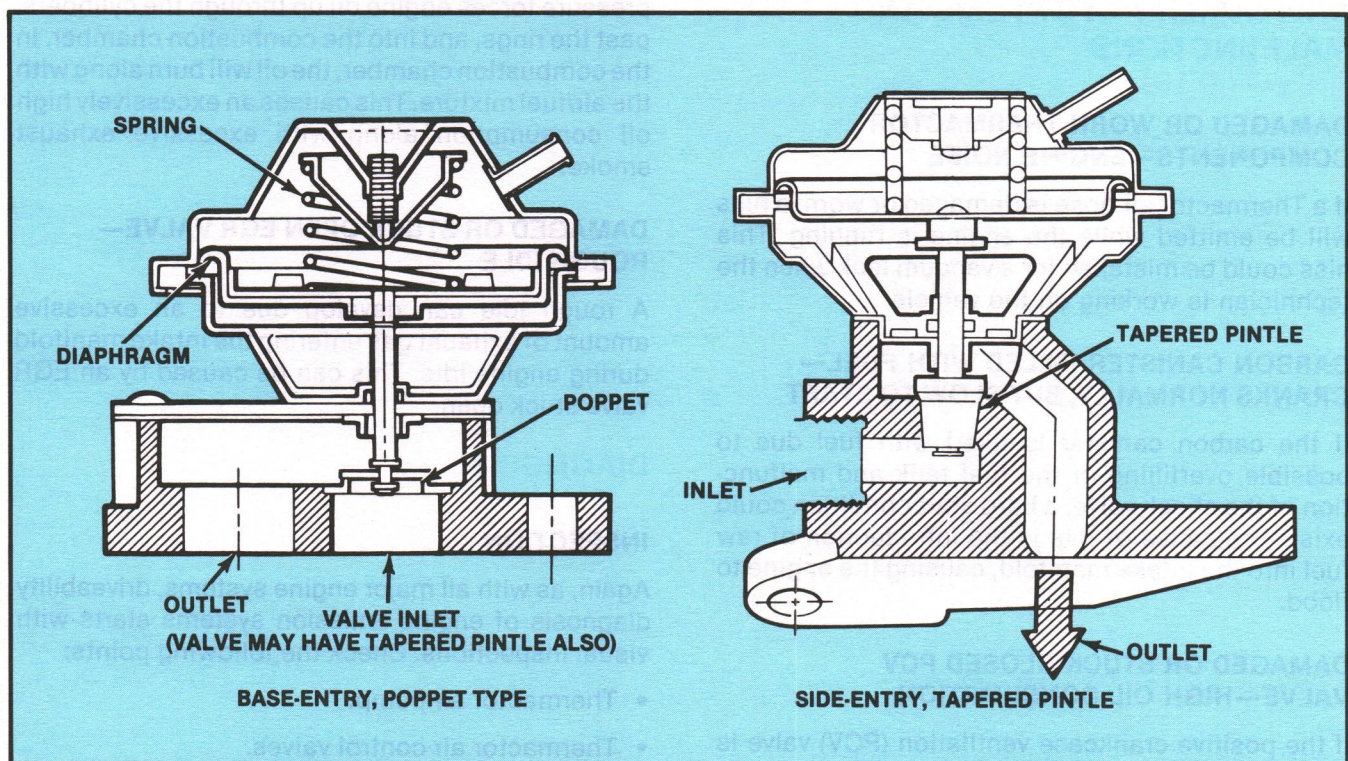


Figure 85. Typical Ported EGR Valves—Base- and Side-Entry Types

EMISSION SYSTEMS

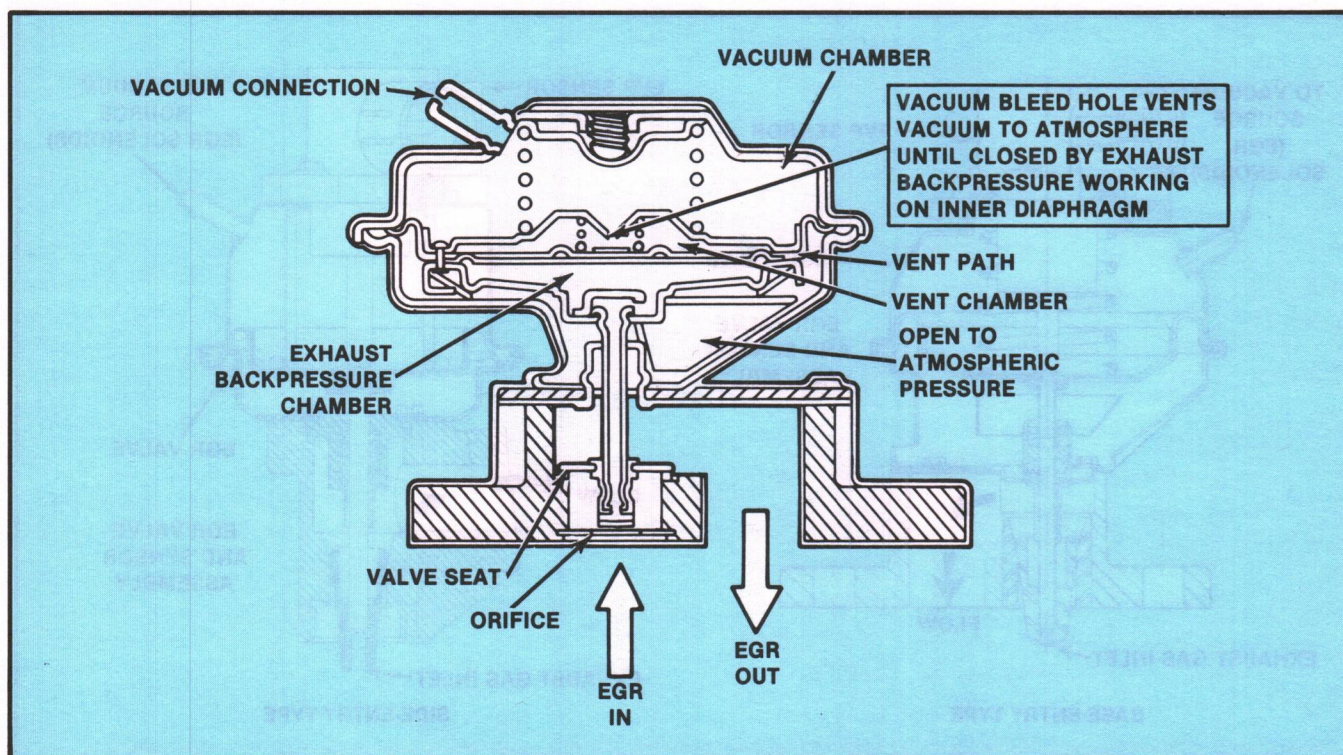


Figure 86. Typical Integral Backpressure EGR Valve

DRIVEABILITY SYMPTOMS AND MALFUNCTIONS

DAMAGED OR WORN THERMATOR COMPONENTS—ENGINE NOISE

If a Thermactor air hose is damaged or worn, a hiss will be emitted while the engine is running. This hiss could be mistaken for a vacuum leak when the technician is working on the vehicle.

CARBON CANISTER FILLED WITH FUEL—CRANKS NORMALLY, BUT SLOW TO START

If the carbon canister is filled with fuel due to possible overfilling of the fuel tank and malfunction of the check valve, a hard start condition could exist. The cause of this is the introduction of raw fuel into the intake manifold, causing the engine to flood.

DAMAGED OR STUCK CLOSED PCV VALVE—HIGH OIL CONSUMPTION

If the positive crankcase ventilation (PCV) valve is damaged or stuck closed due to fouling, excessive pressure builds up in the crankcase. This excessive

pressure forces engine oil up through the cylinders, past the rings, and into the combustion chamber. In the combustion chamber, the oil will burn along with the air/fuel mixture. This causes an excessively high oil consumption along with excessive exhaust smoke.

DAMAGED OR STUCK OPEN EGR VALVE—ROUGH IDLE

A rough idle can develop due to an excessive amount of exhaust gas entering the intake manifold during engine idle. This can be caused by an EGR valve stuck open.

DIAGNOSIS

INSPECTION

Again, as with all major engine systems, driveability diagnosis of engine emission systems starts with visual inspections. Check the following points:

- Thermactor air pump.
- Thermactor air control valves.
- Thermactor air hoses.

- PCV valve—Remove it from the engine to check for rattles. A PCV valve should rattle, which indicates that the valve is not stuck open or closed.
- Carbon canister, purge lines and hoses for damage or wear—Disconnect the vacuum line at the carbon canister and be sure it contains no liquid fuel.
- EGR valve—Determine if it is stuck open or closed.

TESTING

Vacuum Gauge

A vacuum gauge can be used to check for excessive exhaust backpressure.

1. Disconnect a vacuum line connected to an intake manifold port.
2. "Tee" a vacuum gauge between the disconnected vacuum line and the intake manifold port.
3. Connect a tachometer.
4. Start the engine and gradually increase engine speed to 2000 rpm with transmission in NEUTRAL.
5. The reading from the manifold vacuum gauge should be above 16 inches Hg. If not, there could be an excessive backpressure in the exhaust system. To verify an excessive backpressure problem or a vacuum leak, perform the following:
 - a) Turn the engine OFF.
 - b) Disconnect exhaust system at exhaust manifold.
 - c) Repeat Steps 4 and 5.
 - d) If 16 inches of Hg is still not obtained on the gauge, the exhaust manifold is probably blocked. Visually inspect the exhaust manifold for blockage.
 - e) If a reading of 16 inches of Hg is obtained, the blockage is either in the muffler, exhaust pipe(s) or catalytic converter. If the problem is a damaged converter, inspect the muffler to be sure that converter debris has not entered the muffler, causing an obstruction.

Hand Vacuum Pump

A hand vacuum pump can be used to check the operation of the EGR valve. The following is the procedure for checking the EGR valve:

1. Check all vacuum lines for correct routing. Ensure that they are attached securely. Replace cracked, crimped or broken lines.
2. With the engine at normal operating temperature, be certain there is no vacuum to the EGR valve at idle.
3. Install a tachometer.
4. On EFI engines (multi-point injection), disconnect the throttle air bypass valve solenoid.
5. Remove the vacuum supply hose from the EGR valve port and plug the hose.
6. Start the engine and idle with transmission in NEUTRAL, then observe the engine idle speed. If necessary, adjust idle speed to the emission decal specification.
7. Slowly apply 5–10 inches Hg vacuum to the EGR valve vacuum port, using a hand vacuum pump.
8. If any of the following occur when vacuum is applied to the EGR valve, replace the valve.
 - a) Engine does **not** stall.
 - b) Idle speed does **not** drop more than 100 rpm.
 - c) Idle speed does not return to normal (± 25 rpm) after the vacuum is removed.
9. Reconnect the throttle air bypass valve solenoid, if removed.
10. Unplug and reconnect the EGR valve vacuum supply hose. The EGR valve is OK.

Engine Analyzer

An engine analyzer can be used to check the emission systems for correct operation. By inserting the exhaust analyzer probes into the exhaust system, a reading can be obtained to check that the emission standards for the vehicle are being met.

Mixture Lean or Rich at Idle—This can be determined by the amount of hydrocarbons (HC), carbon dioxide (CO₂), carbon monoxide (CO), and oxygen (O₂) detected in the exhaust system. A lean or rich idle condition can also be suspected if a rough idle condition is present. A combination of these emissions indicates the air/fuel ratio is too lean for good idle performance. Review existing specifications and make adjustments, as required, to obtain the lowest exhaust emissions with the best idle condition. If the vehicle is equipped with a Thermoactor air pump or pulse air, disconnect prior to any adjustments.

EMISSION SYSTEMS

If the analysis shows a rich mixture, review the data and make adjustments, as required, to obtain the lowest exhaust emissions with the best idle condition. If the vehicle is equipped with a Thermactor air pump or pulse air, disconnect prior to adjustments.

If an excessive amount of hydrocarbons or carbon monoxide are detected, check the Thermactor system and the catalytic converter for proper operation.

If an excessive amount of oxides of nitrogen are detected, check the EGR system for proper operation.

Refer to the appropriate Ford publication for exhaust emission requirements. There are minimum federal requirements for each model year. Also, some states have their own minimum requirements for vehicles licensed in their states.

1. On ERT engines (multi-point fueling system), disconnect the throttle bypass valve (if equipped).
2. Remove the vacuum supply hose from the EGR valve port and plug the hose.
3. Start the engine and idle with transmission in NEUTRAL. Observe the engine idle speed. If necessary, adjust idle speed to the emission test specification.
4. Slowly apply 5-10 inches Hg vacuum to the EGR valve vacuum port, using a hand vacuum pump.
5. If any of the following occur when vacuum is applied to the EGR valve, replace the valve:
 - a) Engine does not stall.
 - b) Idle speed does not drop more than 100 rpm.
 - c) Idle speed does not return to normal (±25 rpm) after the vacuum is removed.
6. Reconnect the throttle air bypass valve (if not removed).
7. Unplug and reconnect the EGR valve vacuum supply hose. The EGR valve is OK.

Engine Analyzer

An engine analyzer can be used to check the emission systems for correct operation. By inserting the exhaust analyzer probe into the exhaust system, a reading can be obtained to check that the emission standards for the vehicle are being met.

Whether lean or rich, air-fuel ratio can be determined by the amount of hydrocarbons (HC), carbon dioxide (CO₂), carbon monoxide (CO), and oxygen (O₂) detected in the exhaust system. A lean or rich idle condition can also be suspected if a rough idle condition is present. A combination of these emission indicators the exhaust ratio is too lean for good idle performance. Fewer existing specifications and make adjustments as required to obtain the lowest exhaust emissions with the best idle condition. If the vehicle is equipped with a Thermactor air pump or pulse air, disconnect prior to any adjustments.

1. EGR valve—Determine if it is stuck open or closed.
2. Vacuum Gauge
A vacuum gauge can be used to check for excessive exhaust backpressure.
 - a) Disconnect a vacuum line connected to an intake manifold port.
 - b) Test a vacuum gauge between the disconnected vacuum line and the intake manifold port.
 - c) Connect a tachometer.
 - d) Start the engine and gradually increase engine speed to 2000 rpm with transmission in NEUTRAL.
 - e) The reading from the manifold vacuum gauge should be above 15 inches Hg. If not, there could be excessive backpressure in the exhaust system. To verify an excessive backpressure problem or a vacuum leak, perform the following:
 1. Turn the engine OFF.
 2. Disconnect exhaust system at exhaust manifold.
 3. Repeat steps 1 and 2.
 4. If the increase in Hg is still not obtained on the gauge, the exhaust manifold is probably blocked. Visually inspect the exhaust manifold for blockage.
 5. If a reading of 15 inches of Hg is obtained, the blockage is either in the muffler, exhaust pipe(s) or catalytic converter. If the problem is a damaged catalytic converter, inspect the muffler to be sure that converter debris has not entered the muffler, causing an obstruction.

Hand Vacuum Pump

A hand vacuum pump can be used to check the operation of the EGR valve. The following steps are for checking the EGR valve.

GLOSSARY OF TECHNICAL TERMS

ABV (Air Bypass Valve)—A vacuum-controlled valve in the Thermactor system that allows air from the air pump to be injected into the exhaust system or bypassed to atmosphere when not required. It also provides a pressure relief function to protect the air pump from high pressures. These valves may be mounted on the air pump or mounted in the Thermactor hose line (remote mounted). The two basic types are normally closed (bypasses air with no vacuum signal applied) or normally open (allows air to flow through the valve to the exhaust system with no vacuum signal applied).

A/CL BIMET—Air cleaner bimetal sensor.

A/CL DV—Air cleaner duct and valve vacuum.

A/C Relay—Powers A/C clutch circuit and cooling fan motor when A/C or DEFROST is selected.

Active Sensor—A sensor in which the output is taken directly from the sensor.

Actuator—A device that moves or actuates when it receives an electrical (or other) signal.

ACV (Air Control Valve)—A vacuum-controlled valve in the Thermactor system that diverts air pump air to either the upstream (exhaust manifold) or downstream (underbody catalyst) air injection points, as required.

Air Bypass Valve—See ABV.

Air Cleaner—A device for filtering, cleaning, and removing dust from the air admitted to a unit, such as an engine or air compressor.

Air Cleaner Bimetal Sensor—A sensor that controls the air cleaner vacuum door motor in response to temperature changes.

Altitude Compensating Modulator—Device to control transmission shift spacing and engine timing. Improves performance at higher altitudes by changing the vacuum signals.

Ambient Temperature—Temperature of air surrounding an object.

Atmospheric Pressure—The pressure due to the weight of the earth's atmosphere, equal at sea level to approximately 14.69 psi.

Atomization—To reduce a liquid or solid to a fine spray (minute particles).

Automotive Emissions—Gaseous and particulate compounds that are emitted from a car's crankcase, exhaust, carburetor, and fuel tank (hydrocarbons, nitrogen oxides and carbon monoxide).

Backpressure—A resistance to free flow, such as a restriction in the exhaust line.

BHS (Bimetal Heat Sensor)—A unit using a metallic part consisting of two layers with different metals to sense temperature changes. The layers expand at different rates as temperature changes, causing the part to bend in a predetermined manner, thereby causing a changing signal.

Blow-by—A leakage or loss of pressure often used with reference to leakage of compression past the piston rings between the piston and the cylinder.

BPV (Bypass Valve)—A vacuum-controlled valve in the Thermactor system that allows air from the air pump to be injected into the exhaust system, or bypassed to atmosphere when not required. It also provides a pressure relief function to protect the air pump from high pressures. These valves may be mounted on the air pump (pump mounted) or mounted in the Thermactor hose line (remote mounted). The two basic types are: normally closed (bypasses air with no vacuum signal applied) or normally open (allows air to flow through the valve to the exhaust system with no vacuum signal applied).

BV—Bowl Vent (carburetors only) A port located on a carburetor that allows the bowl to vent to the storage canister when engine is not running.

BVT (Backpressure Variable Transducer)—A pressure-controlling device that regulates a pressure downstream of a flow-metering orifice.

Camshaft—The shaft containing lobes or cams to operate the engine valves.

Carbon Canister—A container in an evaporative emission control system that contains charcoal to trap and store vapors from the fuel system.

Carbon Dioxide—A molecule made up of two oxygen atoms and one carbon atom (CO_2). It is a harmless gas and not to be confused with CO (carbon monoxide), which is poisonous and considered a pollutant by the EPA.

Catalytic Converter—A muffler-like device installed in the exhaust system so that hot exhaust gas comes in contact with special metals (i.e., rhodium or palladium) that promote more complete combustion of unburned hydrocarbons and reduction of carbon monoxide.

GLOSSARY OF TECHNICAL TERMS

CFI (Central Fuel Injection)—A system using one or two computer-controlled injector(s) to spray fuel into a throttle body.

Check Valve—A one-way valve that allows a liquid or gas to flow in one direction only—prevents backflow.

Closed Loop—An electronic control circuit in which the output of the electronic control is measured by a sensor to tell (or “feedback”) the electronic control, whether the output is optimum or excessive.

CO (Carbon Monoxide)—A colorless, odorless gas that is a by-product of incomplete combustion of carbon. This gas is poisonous in confined spaces when it is at high concentration.

Cold Weather Modulator—Refer to CWM.

Combination Thermactor Air Bypass and Air Diverter Valve—Combines the function of a normally closed air bypass valve and an air control valve in one integral valve.

Combustion—The process of burning.

Combustion Space or Chamber—In automobile engines, the volume of the cylinder above the piston with the piston on top center.

Compression—The reduction in volume or the “squeezing” of a gas. As applied to metal, such as a coil spring, compression is the opposite of tension.

Compression Stroke—The piston stroke from BTDC to TDC during which both valves are closed and the gases in the cylinder are compressed.

Connecting Rod—Rod connects the piston to the crankshaft.

Coolant—The liquid that circulates in an engine cooling system.

CWM (Cold Weather Modulator)—A vacuum modulator located in the carburetor air cleaner on some models. Prevents the air cleaner duct door from opening to non-heated intake air when fresh air is below 13°C (55°F).

Cylinder—A round hole having some depth bored to receive a piston; also referred to as “bore.”

Dead Center—The extreme upper or lower position of the crankshaft throw at which the piston is not moving in either direction.

Diaphragm—A flexible partition or wall separating two cavities.

Driveability—What an owner expects from a properly operating engine, such as easy starting (hot or cold engine), acceptable smoothness at idle, good acceleration in all speed ranges, instant response and full power. It can also apply to how the transmission operates, the way the vehicle handles, and to owner expectations in regard to noise, vibration and harshness.

DV-TW—Delay Valve—Two-Way. Restricts airflow equally in either direction through a sintered stainless steel disk.

ECA (Electronic Control Assembly)—See processor.

EEC (Electronic Engine Control)—A computer-directed system of engine control. EEC-I—control of engine timing. EEC-II—control of engine timing and fuel (with FBC system). EEC-III—FBC descendent of EEC-II. EEC-III—CFI control of engine timing and fuel (with EFI system). EEC-IV is a descendent of the EEC-III with an FBC, CFI or EFI control system.

EFI (Electronic Fuel Injection)—A system of computer-controlled, multi-point, direct fuel injection into the intake ports.

EGR (Exhaust Gas Recirculation)—A procedure where a small amount of exhaust gas is readmitted to the combustion chamber to reduce peak combustion temperatures and, thus, reduce NO_x emissions.

EGR Cooler Assembly—Heat exchanger using engine coolant to reduce exhaust gas temperature.

Electronic Fuel Charging Assembly (EFCA)—Used on CFI applications and consists of the throttle body, fuel injector, fuel pressure regulator, and throttle kicker (or ISC motor).

Energized—Having an electric current or source turned on.

EPA (Environmental Protection Agency)—Federal agency having responsibility for administering congressional programs relating to the protection of the environment.

EVP Sensor—Exhaust gas recirculation valve position sensor.

Exhaust Manifold—That part of an engine through which exhausted or spent gases flow to the exhaust system.

GLOSSARY OF TECHNICAL TERMS

Exhaust Valve—A valve that permits the exhausted or spent gases to escape from the combustion chamber.

Fuel (Rich, Lean)—A qualitative evaluation of air/fuel ratio based on the voltage from the exhaust gas oxygen (EGO) sensor. If there is an excess of oxygen (EGO voltage 0.4 or less), the mixture is said to be "lean" and if there is insufficient oxygen (EGO voltage 0.6–1.0), the mixture is said to be "rich."

Gasket—Anything used as a packing, such as a non-metallic substance placed between two metal surfaces to act as a seal.

GND (or Ground)—Common line for all vehicle power, vehicle chassis ground and engine block ground, connected to vehicle battery negative terminal.

HC (Hydrocarbon)—Any compound composed of carbon and hydrogen, such as petroleum products. Excessive amounts in the atmosphere are considered undesirable contaminants and a major contributor to air pollution.

H.O.—High output.

Inertia Switch—A switch in the fuel pump circuit, which shuts off power to the fuel pump in the event the vehicle is involved in a collision. This switch must be manually reset.

Inlet Valve or Intake Valve—A valve that permits a fluid or gas to enter a chamber, but prevents exit.

Intake Manifold or Inlet Pipe—The tube used to conduct the gasoline and air mixture from the carburetor to the engine cylinders.

MAP (Manifold Absolute Pressure) Sensor—A sensor or its signal circuit which sends a varying frequency signal to the processor for calculations based on manifold vacuum and manifold pressure.

Module—Any package that is intended to perform a specific task (such as ignition). Usually, modules can be disconnected and replaced easily.

NO_x (Nitrous Oxides)—A compound formed during the engine's combustion process when oxygen in the air combined with nitrogen in the air forms the nitrogen oxides which are agents in photochemical smog.

Oxides of Nitrogen—Refer to NO_x.

PCV (Positive Crankcase Ventilation)—A system that controls the flow of vapors from the crankcase to the engine intake system, where they are burned in the engine cylinders rather than being discharged unburned into the air from the crankcase.

Piston—A cylindrical part closed at one end that is connected to the crankshaft by the connecting rod. The force of the explosion in the cylinder is exerted against the closed end of the piston, causing the connecting rod to move the crankshaft.

Piston Ring—An expanding ring placed in the grooves of the piston to provide a seal to prevent the passage of fluid or gas past the piston.

Ported Vacuum Switch—Refer to PVS.

Pulse Air—Refer to Thermactor II.

Purge CV—Purge Control Valve.

PVS (Ported Vacuum Switch)—A temperature-actuated switch that changes vacuum connections when the coolant temperature changes.

Reed Valve—Type of check valve used on some engine applications. Prevents reverse flow of air from exhaust manifold to intake air cleaner. Used in the Thermactor II system.

Spark—An electrical current possessing sufficient pressure to jump through the air from one conductor to another.

Spark Gap—The space between the electrodes of a spark plug through which the spark jumps. Also, a safety device in a magneto to provide an alternate path for the current when it exceeds a safe value.

Spark Plug—A device inserted into the combustion chamber of an engine, containing an insulated central electrode for conducting the high-tension current from the ignition distributor or magneto. This insulated electrode is spaced a pre-determined distance from the shell or side electrode in order to control the dimensions of the gap for the spark to jump across.

Stroke—In an automobile engine, the distance moved by the piston.

TFI-IV (Thick-Film Integrated) Module—Module that is mounted on the distributor and fires the ignition coil.

TFI Module—Thick-Film Integrated (TFI) Module.

GLOSSARY OF TECHNICAL TERMS

Thermactor—An air-injection type of exhaust emissions control system. A product identification name of Ford Motor Company.

Thermactor II—System similar to Thermactor I that uses pulses occurring naturally in the exhaust system to pulse fresh air into the exhaust manifold. Thermactor II does not use an air pump, but does incorporate a reed valve.

Timing—Relationship between spark plug firing and piston position, usually expressed in crankshaft degrees before or after top dead center (TDC) of compression stroke. Example: 15 degrees BTDC.

Universal Distributor—Distributor used with EEC-IV systems and TFI-IV module, and features the Hall effect device.

Vacuum—A term used to describe a pressure that is less than atmospheric pressure.

Vacuum Gauge—An instrument designed to measure the degree of vacuum existing in a chamber.

Vacuum Reservoir (V Reser)—Stores vacuum and provides “muscle” vacuum. Prevents rapid fluctuations or sudden drops in a vacuum signal, such as those seen during an acceleration period.

Vacuum Restrictor (V Rest)—Orifice-type flow restrictor that controls the flow rate and/or timing to the purge system. The flow rate through the restrictor is the same in both directions.

Vacuum Retard Delay Valve—Delays the loss of a vacuum signal during some vehicle deceleration modes.

Valve—A device for opening and sealing an opening (aperture).

VCV (Vacuum Check Valve)—Used to retain a vacuum signal in the system after vacuum source is gone.

VECI (Vehicle Emissions Control Information)—Critical specifications for servicing emission systems. Decal located in engine compartment.

Volt—A practical unit for measuring current pressure in a circuit; that force, when steadily applied to a conductor with a resistance of one ohm, will produce a current of one ampere.

Voltage—The force (electromotive) that moves electrons through a conductor. It can also be stated as the difference in electrical pressure. One volt moves one ampere of current through one ohm of resistance.

V RESER—Refer to Vacuum Reservoir.

V REST—Refer to Vacuum Restrictor.

DIAGNOSIS EXERCISES

DIRECTIONS

This series of exercise charts is designed to enhance your ability to skillfully diagnose vehicle problems. Separate answer sheets are provided at the end of each exercise. Complete the following sample concern before proceeding with the actual exercises. The following pointers will be helpful:

- When beginning diagnosis of a vehicle concern, assume it is the first time the vehicle has been in the shop with this malfunction.
- Always answer the diagnosis steps in the order that **YOU** would do them.
- Only choose one answer for each box.
- It is important that you choose the most correct answer, even if you feel none of them is correct.
- **ALWAYS** mark your answer immediately on the answer sheet. This is important because the sequence of numbers you create determines if you are using good diagnostic procedures!

I. VEHICLE CONCERN: ENGINE OVERHEATS

1. ALWAYS BEGIN HERE. FIND OUT WHAT THE CONCERN IS.

The following are **ACTIONS** that you may choose to correct the cause of the concern. Remember, choose only one action. Study the choices and once you have determined what you would do first, place that answer in the **first** box of the answer sheet. Then, proceed to that specific **BLOCK NUMBER** for further instructions.

ACTION:

2. THEN CHOOSE THE ACTION THAT YOU WOULD PERFORM FIRST.

- CHECK AND ADJUST IGNITION TIMING
- REPLACE THE WATER PUMP
- FLUSH THE RADIATOR
- CHECK COOLANT LEVEL

NOTE: The blocks are found on the following pages.

ANSWER BLOCK

1
2
3
4

3.

AFTER YOUR CHOICE, PLACE THIS NUMBER IN THE FIRST SQUARE OF THE ANSWER SHEET. REFER TO THE SAMPLE ANSWER SHEET ON PAGE 70.

4.

THEN LOCATE THE ANSWER BLOCK THAT MATCHES THE NUMBER YOU CHOSE. FOR THIS SAMPLE CONCERN, THE ANSWER BLOCKS APPEAR ON PAGES 68 AND 69.

DIAGNOSIS EXERCISES

BLOCK NUMBER 1

You have elected to check the ignition timing of this vehicle. The timing is at the proper specification. Of the **ACTIONS** listed below, which would be your **NEXT** choice? **Place your answer in the NEXT box of the answer sheet, and proceed to that BLOCK NUMBER for further instructions.**

ACTION:

- REPLACE THE WATER PUMP
- CHECK COOLANT LEVEL
- FLUSH THE RADIATOR

ANSWER BLOCK

2
4
3

BLOCK NUMBER 2

You have elected to install a new water pump. All of the repair procedures were done correctly and the vehicle has been returned to the customer. Two weeks later, the vehicle was returned with the same concern. Of the **ACTIONS** listed below, which would be your **NEXT** choice? **Place your answer in the NEXT box of the answer sheet, and proceed to that BLOCK NUMBER for further instructions.**

ACTION:

- CHECK COOLANT LEVEL
- FLUSH THE RADIATOR
- RECHECK THE WATER PUMP
- CHECK AND ADJUST IGNITION TIMING

ANSWER BLOCK

4
3
5
6

BLOCK NUMBER 3

You have elected to flush the cooling system. After refilling and a test drive, the vehicle was returned to the customer. Two weeks later, the vehicle was returned with the same concern. Of the **ACTIONS** listed below, which would be your **NEXT** choice? **Place your answer in the NEXT box of the answer sheet, and proceed to that BLOCK NUMBER for further instructions.**

ACTION:

- RECHECK THE WATER PUMP
- RECHECK AND ADJUST IGNITION TIMING
- REFLUSH THE COOLING SYSTEM
- CHECK COOLANT LEVEL

ANSWER BLOCK

5
6
7
4

BLOCK NUMBER 4

You have elected to check the coolant level. You found the recovery system empty and the radiator low on coolant. Pressure testing the cooling system uncovers a leak into the combustion chamber at the right rear cylinder head. Your diagnosis and repairs are correct. You have now completed this sample exercise. Please turn to page 6 to begin the exercises.

BLOCK NUMBER 5

You have checked or replaced items that are not damaged. Remember, the diagnostic steps should begin with the easy checks first and the more difficult ones last. Please review the sample exercise again before continuing.

DIAGNOSIS EXERCISES

BLOCK NUMBER 6

You have checked or replaced items that are not damaged. Remember, the diagnostic steps should begin with the easy checks first and the more difficult ones last. Please review the sample exercise again before continuing.

BLOCK NUMBER 7

You have checked or replaced items that are not damaged. Remember, the diagnostic steps should begin with the easy checks first and the more difficult ones last. Please review the sample exercise again before continuing.

SAMPLE CORRECT ANSWER

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SAMPLE INCORRECT ANSWER

--	--	--	--	--	--	--	--	--	--

DIAGNOSIS EXERCISES

SAMPLE VEHICLE CONCERN: ENGINE OVERHEATS

5. PLACE YOUR ANSWERS HERE.

SAMPLE EXERCISE ANSWERS

4									
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NOTE: Enter your answers from left to right! Remember, you might not use all of the answer squares.

6. WHEN YOU ARE FINISHED, YOUR ANSWERS ABOVE SHOULD MATCH THE ANSWER KEY BELOW. IF NOT, USE THE ANSWER KEY TO FOLLOW THE CORRECT PATH.

SAMPLE CORRECT ANSWER

4									
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SAMPLE INCORRECT ANSWER

3	6								
---	---	--	--	--	--	--	--	--	--

II. VEHICLE CONCERN: ENGINE IDLES ROUGH/MISFIRES DURING CRUISE

The following are **ACTIONS** that you may choose to correct the cause of the concern. Remember, choose only one action. Study the choices and once you have determined what you would do first, place that answer in the **first** box of the answer sheet. Then, proceed to that specific **BLOCK NUMBER** for further instructions.

ACTION:	ANSWER BLOCK
• TEST DRIVE VEHICLE	1
• PERFORM VISUAL UNDER-HOOD INSPECTION	2
• TEST IGNITION WITH ENGINE ANALYZER	3
• PERFORM ENGINE TUNE-UP	4

BLOCK NUMBER 1

A vehicle test drive confirms the concern. Misfiring occurs during cruise **ONLY** and the idle is rough. Acceleration and demand performance is normal. The rough idle is eliminated by applying a load on the engine with minor brake torque. Of the **ACTIONS** listed below, which would be your **NEXT** choice? Place your answer in the **NEXT** box of the answer sheet, and proceed to that **BLOCK NUMBER** for further instructions.

ACTION:	ANSWER BLOCK
• PERFORM ENGINE TUNE-UP	4
• PERFORM VISUAL UNDER-HOOD INSPECTION	2
• CHECK EXHAUST SYSTEM FOR RESTRICTION	5
• CHECK ENGINE FOR VACUUM LEAKS	11

BLOCK NUMBER 2

An inspection under the hood reveals all routing and connections are secure. No unusual noises are heard while the engine is idling rough. Of the **ACTIONS** listed below, which would be your **NEXT** choice? Place your answer in the **NEXT** box of the answer sheet, and proceed to that **BLOCK NUMBER** for further instructions.

ACTION:	ANSWER BLOCK
• PERFORM CYLINDER COMPRESSION TEST	7
• PERFORM FUEL SYSTEM DIAGNOSIS	8
• TEST DRIVE VEHICLE	1
• CHECK IDLE MIXTURE USING PROPANE METHOD	9

DIAGNOSIS EXERCISES

BLOCK NUMBER 3

An engine analyzer test of the engine reveals no serious ignition malfunctions. Timing is within specifications. The vacuum gauge on the engine analyzer indicates lower than normal intake vacuum and slightly erratic needle movement at idle. Of the **ACTIONS** listed below, which would be your **NEXT** choice? **Place your answer in the NEXT box of the answer sheet, and proceed to that BLOCK NUMBER for further instructions.**

ACTION:

- CHECK EXHAUST SYSTEM FOR RESTRICTION
- TEST DRIVE VEHICLE
- CHECK IDLE MIXTURE USING PROPANE METHOD
- CHECK ENGINE FOR VACUUM LEAKS

ANSWER BLOCK

- 5
- 6
- 9
- 11

BLOCK NUMBER 4

You have elected to tune the engine and set the timing. After completion of the repairs, engine operation has not improved. Of the **ACTIONS** listed below, which would be your **NEXT** choice? **Place your answer in the NEXT box of the answer sheet, and proceed to that BLOCK NUMBER for further instructions.**

ACTION:

- PERFORM VISUAL UNDER-HOOD INSPECTION
- CHECK IGNITION WITH ENGINE ANALYZER
- PERFORM FUEL SYSTEM DIAGNOSIS
- CHECK IDLE MIXTURE USING PROPANE METHOD

ANSWER BLOCK

- 11
- 3
- 8
- 9

BLOCK NUMBER 5

A visual inspection of the exhaust system shows no signs of external damage. The system is replaced to ensure there are no restrictions. The problem has not been corrected. Of the **ACTIONS** listed below, which would be your **NEXT** choice? **Place your answer in the NEXT box of the answer sheet, and proceed to that BLOCK NUMBER for further instructions.**

ACTION:

- PERFORM FUEL SYSTEM DIAGNOSIS
- PERFORM CYLINDER COMPRESSION TEST
- REMOVE AND INSPECT CAMSHAFT
- CHECK IDLE MIXTURE USING PROPANE METHOD

ANSWER BLOCK

- 8
- 7
- 10
- 9

DIAGNOSIS EXERCISES

BLOCK NUMBER 6

A vehicle test drive confirms the concern. Misfiring occurs during cruise **ONLY** and the idle is rough. Acceleration and demand performance is normal. The rough idle is eliminated by applying a load on the engine with minor brake torque. Of the **ACTIONS** listed below, which would be your **NEXT** choice? **Place your answer in the NEXT box of the answer sheet, and proceed to that BLOCK NUMBER for further instructions.**

ACTION:	ANSWER BLOCK
• CHECK IGNITION WITH ENGINE ANALYZER	12
• CHECK INTAKE MANIFOLD VACUUM	11
• CHECK EXHAUST SYSTEM FOR RESTRICTION	5
• PERFORM FUEL SYSTEM DIAGNOSIS	8

BLOCK NUMBER 7

A compression test of all the cylinders reveals no problem. All cylinders are within specification. Of the **ACTIONS** listed below, which would be your **NEXT** choice? **Place your answer in the NEXT box of the answer sheet, and proceed to that BLOCK NUMBER for further instructions.**

ACTION:	ANSWER BLOCK
• REPLACE EGR VALVE	13
• PERFORM EVAPORATIVE EMISSIONS DIAGNOSIS	15
• CHECK IDLE MIXTURE USING PROPANE METHOD	9
• PERFORM FUEL SYSTEM DIAGNOSIS	8

BLOCK NUMBER 8

A test of the fuel system does not reveal a malfunction. Operation is as the service manual indicates; however, the vehicle still performs poorly. Of the **ACTIONS** listed below, which would be your **NEXT** choice? **Place your answer in the NEXT box of the answer sheet, and proceed to that BLOCK NUMBER for further instructions.**

ACTION:	ANSWER BLOCK
• PERFORM EVAPORATIVE EMISSIONS DIAGNOSIS	15
• REPLACE EGR VALVE	13
• CHECK FOR LOOSE OR CRACKED COOLING FAN	14
• REPLACE PCV VALVE	15

DIAGNOSIS EXERCISES

BLOCK NUMBER 9

Propane enrichment indicates that the mixture is leaner than normal. After adjusting the mixture, a problem condition still exists; the vehicle runs better but fails an emission test. Of the **ACTIONS** listed below, which would be your **NEXT** choice? **Place your answer in the NEXT box of the answer sheet, and proceed to that BLOCK NUMBER for further instructions.**

ACTION:

- PERFORM FUEL SYSTEM DIAGNOSIS
- PERFORM EVAPORATIVE EMISSIONS DIAGNOSIS
- REMOVE AND INSPECT CAMSHAFT
- PERFORM CYLINDER COMPRESSION TEST

ANSWER BLOCK

8

13

10

7

BLOCK NUMBER 10

The camshaft should be replaced only if it is damaged. The camshaft in this vehicle is without fault. Your diagnostic procedures need improvement. Remember, exhaust all the easy quick checks before proceeding to the more difficult ones. Using the answer key, follow the block sequence to determine the correct diagnostic path.

BLOCK NUMBER 11

A gauge check of the intake manifold vacuum reveals vacuum is low and fluctuating slightly. This indicates a vacuum leak. Squirting water on the vacuum lines and components does not change the engine idling quality. When water is squirted where the intake manifold joins the cylinder head the engine runs properly. Your diagnosis has led you to a leaking intake manifold gasket! You have completed this exercise. Now, continue to exercise III. Vehicle Concern: Engine Surges.

BLOCK NUMBER 12

An engine analyzer test of the engine reveals no serious ignition malfunctions. Timing is within specifications. The vacuum gauge on the engine analyzer indicates lower than normal intake vacuum and slightly erratic needle movement at idle. Of the **ACTIONS** listed below, which would be your **NEXT** choice? **Place your answer in the NEXT box of the answer sheet, and proceed to that BLOCK NUMBER for further instructions.**

ACTION:

- DIAGNOSE INTAKE MANIFOLD VACUUM
- REMOVE AND INSPECT CAMSHAFT
- CHECK IDLE MIXTURE USING PROPANE METHOD

ANSWER BLOCK

11

10

9

BLOCK NUMBER 13

Your diagnostic procedures need improvement. Remember, exhaust all the easy quick checks before proceeding to the more difficult ones. Using the answer key, follow the block sequence to determine the correct diagnostic path.



BLOCK NUMBER 14

Your diagnostic procedures need improvement. Remember, exhaust all the easy quick checks before proceeding to the more difficult ones. Using the answer key, follow the block sequence to determine the correct diagnostic path.

BLOCK NUMBER 15

Your diagnostic procedures need improvement. Remember, exhaust all the easy quick checks before proceeding to the more difficult ones. Using the answer key, follow the block sequence to determine the correct diagnostic path.

DIAGNOSIS EXERCISES

II. VEHICLE CONCERN: ENGINE IDLES ROUGH/MISFIRES DURING CRUISE

ANSWER SHEET

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NOTE: Enter your answers from left to right! Remember, you might not use all of the answer squares.

SEE ANSWER KEY ON PAGE 132

DIAGNOSIS EXERCISES

III. VEHICLE CONCERN: ENGINE SURGES

The following are **ACTIONS** that you may choose to correct the cause of the concern. Remember, choose only one action. Study the choices and once you have determined what you would do first, place that answer in the **first** box of the answer sheet. Then, proceed to that specific **BLOCK NUMBER** for further instructions.

ACTION:

- TEST DRIVE VEHICLE
- PERFORM VISUAL UNDER-HOOD INSPECTION
- TEST IGNITION WITH ENGINE ANALYZER
- CHECK AND ADJUST IGNITION TIMING

ANSWER BLOCK

- 1
- 2
- 3
- 4

BLOCK NUMBER 1

You have elected to perform a test drive to evaluate the concern. Different driving techniques did not result in adverse changes in engine performance or driveability. Of the **ACTIONS** listed below, which would be your **NEXT** choice? Place your answer in the **NEXT** box of the answer sheet, and proceed to that **BLOCK NUMBER** for further instructions.

ACTION:

- RETURN VEHICLE TO CUSTOMER, NO PROBLEM FOUND
- TALK WITH DRIVER OF VEHICLE
- PERFORM VISUAL UNDER-HOOD INSPECTION

ANSWER BLOCK

- 5
- 6
- 2

BLOCK NUMBER 2

A visual inspection of the under-hood compartment has been performed. Nothing unusual is noted. All connections are verified and the fluid levels are acceptable. Of the **ACTIONS** listed below, which would be your **NEXT** choice? Place your answer in the **NEXT** box of the answer sheet, and proceed to that **BLOCK NUMBER** for further instructions.

ACTION:

- RETURN VEHICLE TO CUSTOMER, NO PROBLEM FOUND
- TEST DRIVE VEHICLE
- PERFORM FUEL SYSTEM DIAGNOSIS
- TEST IGNITION WITH ENGINE ANALYZER

ANSWER BLOCK

- 5
- 1
- 7
- 3

DIAGNOSIS EXERCISES

BLOCK NUMBER 3

A check of the vehicle's ignition system using an engine analyzer reveals nothing unusual. All operating functions are normal. Of the **ACTIONS** listed below, which would be your **NEXT** choice? **Place your answer in the NEXT box of the answer sheet, and proceed to that BLOCK NUMBER for further instructions.**

ACTION:

- RETURN VEHICLE TO CUSTOMER, NO PROBLEM FOUND
- PERFORM FUEL SYSTEM DIAGNOSIS
- TALK WITH DRIVER OF VEHICLE

ANSWER BLOCK

5
7
6

BLOCK NUMBER 4

Initial vehicle timing meets manufacturer's specification. All advance systems are functioning. Of the **ACTIONS** listed below, which would be your **NEXT** choice? **Place your answer in the NEXT box of the answer sheet, and proceed to that BLOCK NUMBER for further instructions.**

ACTION:

- RETURN VEHICLE TO CUSTOMER, NO PROBLEM FOUND
- TEST IGNITION WITH ENGINE ANALYZER
- PERFORM FUEL SYSTEM DIAGNOSIS

ANSWER BLOCK

5
3
7

BLOCK NUMBER 5

The vehicle is returned to the customer. However, later that day the customer returns the vehicle with the same complaint. Of the **ACTIONS** listed below, which would be your **NEXT** choice? **Place that answer in the NEXT box of the answer sheet, and proceed to that BLOCK NUMBER for further instructions.**

ACTION:

- TEST DRIVE VEHICLE
- ADJUST IDLE MIXTURE USING PROPANE METHOD
- PERFORM EGR SYSTEM DIAGNOSIS
- PERFORM VISUAL UNDER-HOOD INSPECTION

ANSWER BLOCK

8
10
9
2

BLOCK NUMBER 6

After a discussion with the driver of the vehicle it is discovered that the problem seems to occur only when the cruise control is in use. Of the **ACTIONS** listed below, which would be your **NEXT** choice? **Place your answer in the NEXT box of the answer sheet, and proceed to that BLOCK NUMBER for further instructions.**

ACTION:

- TEST DRIVE VEHICLE
- PERFORM FUEL SYSTEM DIAGNOSIS
- PERFORM EGR SYSTEM DIAGNOSIS
- DIAGNOSE CRUISE CONTROL MALFUNCTION

ANSWER BLOCK

8
7
9
11

DIAGNOSIS EXERCISES

BLOCK NUMBER 7

You have elected to perform a fuel system diagnostic test. At this point, too much time has been spent on the vehicle. There is nothing wrong with the fuel system. Remember, exhaust all the easy quick checks before proceeding to the more difficult ones. Using the answer key, follow the block sequence to determine the correct diagnostic path.

BLOCK NUMBER 8

A vehicle test drive using the cruise control verifies the complaint. The vehicle surges during cruise operation only. Of the **ACTIONS** listed below, which would be your **NEXT** choice? **Place your answer in the NEXT box of the answer sheet, and proceed to that BLOCK NUMBER for further instructions.**

ACTION:

ANSWER BLOCK

- | | |
|--|----|
| • PERFORM FUEL SYSTEM DIAGNOSIS | 7 |
| • PERFORM EGR SYSTEM DIAGNOSIS | 9 |
| • ADJUST IDLE MIXTURE USING PROPANE METHOD | 10 |
| • DIAGNOSE CRUISE CONTROL MALFUNCTION | 11 |

BLOCK NUMBER 9

You have elected to perform an EGR system diagnostic test. At this point, too much time has been spent on the vehicle. There is nothing wrong with the EGR system. Remember, exhaust all of the easy quick checks before proceeding to the more difficult ones. Using the answer key, follow the block sequence to determine the correct diagnostic path.

BLOCK NUMBER 10

You have elected to perform a propane enrichment mixture test. At this point, too much time has been spent on the vehicle. There is nothing wrong with the fuel mixture. Remember, exhaust all the easy quick checks before proceeding to the more difficult ones. Using the answer key, follow the block sequence to determine the correct diagnostic path.

BLOCK NUMBER 11

The problem has been solved! After an inspection of the cruise system it is discovered that the servo is ruptured. The vehicle is finally repaired! Now that you have completed this exercise, continue to exercise IV. Vehicle Concern: Stalls or Hesitates on Acceleration.

DIAGNOSIS EXERCISES

III. VEHICLE CONCERN: ENGINE SURGES

ANSWER SHEET

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NOTE: Enter your answers from left to right! Remember, you might not use all of the answer squares.

IV. VEHICLE CONCERN: STALLS OR HESITATES ON ACCELERATION

The following are **ACTIONS** that you may choose to correct the cause of the concern. Remember, choose only one action. Study the choices and once you have determined what you would do first, place your answer in the **first** box of the answer sheet. Then, proceed to that specific **BLOCK NUMBER** for further instructions.

ACTION:	ANSWER BLOCK
• TEST DRIVE VEHICLE	1
• PERFORM VISUAL UNDER-HOOD INSPECTION	2
• PERFORM FUEL SYSTEM DIAGNOSIS	3
• CHECK AND ADJUST IGNITION TIMING	4

BLOCK NUMBER 1

A vehicle test drive confirms the concern. Any acceleration from a stop brings about a hesitation and possibly a stall. However, idle quality is good and the vehicle seems to perform normally. The vehicle cruises at high speed with no problem. Of the **ACTIONS** listed below, which would be your **NEXT** choice? Place your answer in the **NEXT** box of the answer sheet, and proceed to that **BLOCK NUMBER** for further instructions.

ACTION:	ANSWER BLOCK
• PERFORM VISUAL UNDER-HOOD INSPECTION	2
• CHECK AND ADJUST IGNITION TIMING	4
• TEST IGNITION WITH ENGINE ANALYZER	5
• PERFORM FUEL SYSTEM DIAGNOSIS	3

BLOCK NUMBER 2

A visual inspection of the under-hood compartment has been performed. Nothing unusual is noted. All connections are verified and the fluid levels are acceptable. Of the **ACTIONS** listed below, which would be your **NEXT** choice? Place your answer in the **NEXT** box of the answer sheet, and proceed to that **BLOCK NUMBER** for further instructions.

ACTION:	ANSWER BLOCK
• TEST DRIVE VEHICLE	1
• TEST IGNITION WITH ENGINE ANALYZER	5
• PERFORM FUEL SYSTEM DIAGNOSIS	3
• CHECK AND ADJUST IGNITION TIMING	4

DIAGNOSIS EXERCISES

BLOCK NUMBER 3

A test of the fuel delivery system produces nothing unusual. Pressure and volume are within specification. Of the **ACTIONS** listed below, which would be your **NEXT** choice? **Place your answer in the NEXT box of the answer sheet, and proceed to that BLOCK NUMBER for further instructions.**

ACTION:

- PERFORM ENGINE TUNE-UP
- CHECK EXHAUST SYSTEM FOR RESTRICTION
- CHECK EGR VALVE AND VACUUM CONNECTION
- CHECK HEATED AIR INTAKE OPERATION

ANSWER BLOCK

- 6
- 7
- 8
- 10

BLOCK NUMBER 4

You have elected to check the initial timing of the engine. It is within specification, and advance is noted when engine rpm is raised. Of the **ACTIONS** listed below, which would be your **NEXT** choice? **Place your answer in the NEXT box of the answer sheet, and proceed to that BLOCK NUMBER for further instructions.**

ACTION:

- CHECK EGR VALVE AND VACUUM CONNECTION
- PERFORM ENGINE TUNE-UP
- CHECK HEATED AIR INTAKE OPERATION
- CHECK EXHAUST SYSTEM FOR RESTRICTION

ANSWER BLOCK

- 8
- 6
- 10
- 7

BLOCK NUMBER 5

You have elected to verify proper ignition operation. The engine analyzer shows lower than normal required voltage, with spark duration (burn line) below specifications. Of the **ACTIONS** listed below, which would be your **NEXT** choice? **Place your answer in the NEXT box of the answer sheet, and proceed to that BLOCK NUMBER for further instructions.**

ACTION:

- PERFORM ENGINE TUNE-UP
- CHECK SPARK PLUGS FOR FOULING
- CHECK HEATED AIR INTAKE OPERATION

ANSWER BLOCK

- 6
- 9
- 10

BLOCK NUMBER 6

You believe that the engine may need a tune-up. Authorization has been obtained from the vehicle owner. After the parts are installed the vehicle is tested again using the engine analyzer. No change has been noted. A test drive indicates that the vehicle still has a problem. Of the **ACTIONS** listed below, which would be your **NEXT** choice? **Place your answer in the NEXT box of the answer sheet, and proceed to that BLOCK NUMBER for further instructions.**

ACTION:

- CHECK HEATED AIR INTAKE OPERATION
- REPLACE IGNITION MODULE
- CHECK EXHAUST SYSTEM FOR RESTRICTION

ANSWER BLOCK

- 10
- 13
- 7

DIAGNOSIS EXERCISES

BLOCK NUMBER 7

You have decided to check the exhaust system for a restriction. All of the external exhaust components are in good condition. The system has been disassembled and internally inspected. It appears to be acceptable. Of the **ACTIONS** listed below, which would be your **NEXT** choice? **Place your answer in the NEXT box of the answer sheet, and proceed to that BLOCK NUMBER for further instructions.**

ACTION:

- REPLACE IGNITION MODULE
- CHECK HEATED AIR INTAKE OPERATION
- CHECK EGR VALVE AND VACUUM CONNECTION

ANSWER BLOCK

13

10

8

BLOCK NUMBER 8

You have elected to perform an EGR system diagnostic test. At this point, too much time has been spent on the vehicle. There is nothing wrong with the EGR system. Remember, exhaust all the easy quick checks before proceeding to the more difficult ones. Using the answer key, follow the block sequence to determine the correct diagnostic path.

BLOCK NUMBER 9

The spark plugs have been removed from the engine. No evidence of severe fouling is noted. The plugs are slightly sooty as though the fuel is not being completely burned. Of the **ACTIONS** listed below, which would be your **NEXT** choice? **Place your answer in the NEXT box of the answer sheet, and proceed to that BLOCK NUMBER for further instructions.**

ACTION:

- TEST IGNITION COIL RESISTANCE
- VERIFY PROPER VOLTAGE AT IGNITION COIL
- REPLACE IGNITION MODULE

ANSWER BLOCK

11

12

13

BLOCK NUMBER 10

You have elected to perform an air induction system diagnostic test. At this point, too much time has been spent on the vehicle. There is nothing wrong with the air induction system. Remember, exhaust all the easy quick checks before proceeding to the more difficult ones. Using the answer key, follow the block sequence to determine the correct diagnostic path.

BLOCK NUMBER 11

A resistance test of the ignition coil reveals that the secondary winding is shorted. This would explain the engine analyzer pattern and driveability concern. Your diagnosis is right on target! Now that you have completed this exercise, continue to exercise V. Vehicle Concern: Cranks Normally But Won't Start.

DIAGNOSIS EXERCISES

BLOCK NUMBER 12

A test of the ignition coil input voltage reveals a satisfactory system. Of the **ACTIONS** listed below, which would be your **NEXT** choice? Place your answer in the **NEXT** box of the answer sheet, and proceed to that **BLOCK NUMBER** for further instructions.

ACTION:

- TEST IGNITION COIL RESISTANCE
- CHECK HEATED AIR INTAKE OPERATION
- REPLACE IGNITION MODULE

ANSWER BLOCK

11

10

13

BLOCK NUMBER 13

You have elected to replace the ignition module. Components should not be replaced unless proved to be damaged. At this point, too much time has been spent on the vehicle. There is nothing wrong with the module. Remember, exhaust all the easy quick checks before proceeding to the more difficult ones. Using the answer key, follow the block sequence to determine the correct diagnostic path.

DIAGNOSIS EXERCISES

IV. VEHICLE CONCERN: STALLS OR HESITATES ON ACCELERATION

ANSWER SHEET

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NOTE: Enter your answers from left to right! Remember, you might not use all of the answer squares.

SEE ANSWER KEY ON PAGE 132

DIAGNOSIS EXERCISES

V. VEHICLE CONCERN: CRANKS NORMALLY BUT WON'T START

The following are **ACTIONS** that you may choose to correct the cause of the concern. Remember, choose only one action. Study the choices and once you have determined what you would do first, place your answer in the **first** box of the answer sheet. Then, proceed to that specific **BLOCK NUMBER** for further instructions.

ACTION:

- VERIFY ENGINE IS RECEIVING FUEL
- PERFORM VISUAL UNDER-HOOD INSPECTION
- CHECK FOR SPARK AT PLUGS
- CHECK AIR INDUCTION SYSTEM FOR RESTRICTION

ANSWER BLOCK

- 1
- 2
- 3
- 4

BLOCK NUMBER 1

You have elected to verify whether or not the vehicle is receiving fuel. This is a good beginning test, but it doesn't help this time. Adequate fuel is being delivered to the engine. Of the **ACTIONS** listed below, which would be your **NEXT** choice? **Place your answer in the NEXT box of the answer sheet, and proceed to that BLOCK NUMBER for further instructions.**

ACTION:

- PERFORM VISUAL UNDER-HOOD INSPECTION
- CHECK FOR SPARK AT PLUGS
- CHECK AIR INDUCTION SYSTEM FOR RESTRICTION
- REPLACE IGNITION MODULE

ANSWER BLOCK

- 2
- 3
- 4
- 5

BLOCK NUMBER 2

An inspection under the hood reveals nothing unusual. All wires, vacuum lines, and components are acceptable. Of the **ACTIONS** listed below, which would be your **NEXT** choice? **Place your answer in the NEXT box of the answer sheet, and proceed to that BLOCK NUMBER for further instructions.**

ACTION:

- VERIFY ENGINE IS RECEIVING FUEL
- CHECK FOR SPARK AT PLUGS
- CHECK ENGINE COMPRESSION
- CHECK FOR PLUGGED FUEL FILTER

ANSWER BLOCK

- 1
- 3
- 8
- 6

BLOCK NUMBER 3

You have elected to check for an ignition spark. No spark is present from the ignition coil. Of the **ACTIONS** listed below, which would be your **NEXT** choice? **Place your answer in the NEXT box of the answer sheet, and proceed to that BLOCK NUMBER for further instructions.**

ACTION:

ANSWER BLOCK

- | | |
|---|---|
| • REPLACE HALL EFFECT DEVICE IN DISTRIBUTOR | 9 |
| • TEST NEGATIVE TERMINAL OF IGNITION COIL WITH A TEST LIGHT | 7 |
| • CHECK AIR INDUCTION SYSTEM FOR RESTRICTION | 4 |
| • REPLACE IGNITION MODULE | 5 |

BLOCK NUMBER 4

A check of the air induction system reveals no problems. The air cleaner is not plugged and the components are acceptable. Of the **ACTIONS** listed below, which would be your **NEXT** choice? **Place your answer in the NEXT box of the answer sheet, and proceed to that BLOCK NUMBER for further instructions.**

ACTION:

ANSWER BLOCK

- | | |
|---|---|
| • CHECK FOR PLUGGED FUEL FILTER | 6 |
| • REPLACE IGNITION MODULE | 5 |
| • REPLACE HALL EFFECT DEVICE IN DISTRIBUTOR | 9 |
| • CHECK ENGINE COMPRESSION | 8 |

BLOCK NUMBER 5

You have elected to replace the ignition module. However, doing so has not corrected the problem. The ignition still fails to produce spark. Of the **ACTIONS** listed below, which would be your **NEXT** choice? **Place your answer in the NEXT box of the answer sheet, and proceed to that BLOCK NUMBER for further instructions.**

ACTION:

ANSWER BLOCK

- | | |
|---|---|
| • REPLACE HALL EFFECT DEVICE IN DISTRIBUTOR | 9 |
| • CHECK ENGINE COMPRESSION | 8 |
| • CHECK FOR PLUGGED FUEL FILTER | 6 |

BLOCK NUMBER 6

You have elected to remove and inspect the fuel filter. The filter is acceptable. Of the **ACTIONS** listed below, which would be your **NEXT** choice? **Place your answer in the NEXT box of the answer sheet, and proceed to that BLOCK NUMBER for further instructions.**

ACTION:

ANSWER BLOCK

- | | |
|---|----|
| • REPLACE HALL EFFECT DEVICE IN DISTRIBUTOR | 9 |
| • TEST IGNITION COIL RESISTANCE | 10 |
| • CHECK ENGINE COMPRESSION | 8 |

DIAGNOSIS EXERCISES

BLOCK NUMBER 7

You have decided to evaluate the primary circuit of the ignition coil. A 12-volt test light is placed at the negative terminal of the ignition coil. The ignition switch is turned to the ON position. The lamp is on and bright. When the engine is cranked, the lamp flickers. Of the **ACTIONS** listed below, which would be your **NEXT** choice? **Place your answer in the NEXT box of the answer sheet, and proceed to that BLOCK NUMBER for further instructions.**

ACTION:

- REPLACE HALL EFFECT DEVICE IN DISTRIBUTOR
- TEST IGNITION COIL RESISTANCE
- REPLACE IGNITION MODULE

ANSWER BLOCK

9
10
5

BLOCK NUMBER 8

You have elected to perform a compression test on the vehicle. All cylinders are within specification. Of the **ACTIONS** listed below, which would be your **NEXT** choice? **Place your answer in the NEXT box of the answer sheet, and proceed to that BLOCK NUMBER for further instructions.**

ACTION:

- REPLACE HALL EFFECT DEVICE IN DISTRIBUTOR
- REPLACE IGNITION MODULE

ANSWER BLOCK

9
5

BLOCK NUMBER 9

You have elected to replace the Hall effect device in the distributor. At this point, too much time has been spent on the vehicle. There is nothing wrong with the Hall effect device. Remember, exhaust all the easy quick checks before proceeding to the more difficult ones. Using the answer key, follow the block sequence to determine the correct diagnostic path.

BLOCK NUMBER 10

You have elected to test the ignition coil with an ohmmeter. This test leads you to an open in the secondary winding. The problem has been found! Now that you have completed this exercise, continue to exercise VI. Vehicle Concern: Engine Noise (Knocks).

DIAGNOSIS EXERCISES

V. VEHICLE CONCERN: CRANKS NORMALLY BUT WON'T START

ANSWER SHEET

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NOTE: Enter your answers from left to right! Remember, you might not use all of the answer squares.

SEE ANSWER KEY ON PAGE 132

DIAGNOSIS EXERCISES

VI. VEHICLE CONCERN: ENGINE NOISE (KNOCKS)

The following are **ACTIONS** that you may choose to correct the cause of the concern. Remember, choose only one action. Study the choices and once you have determined what you would do first, place your answer in the **first** box of the answer sheet. Then, proceed to that specific **BLOCK NUMBER** for further instructions.

ACTION:

ANSWER BLOCK

- | | |
|--|---|
| • TEST DRIVE VEHICLE | 1 |
| • TALK WITH DRIVER OF VEHICLE | 2 |
| • PERFORM VISUAL UNDER-HOOD INSPECTION | 3 |
| • CHECK LEVEL OF ENGINE OIL | 4 |

BLOCK NUMBER 1

You have elected to take the vehicle for a test drive. The engine was still warm before your departure. During the evaluation no unusual noises from the engine or drivetrain were heard. Of the **ACTIONS** listed below, which would be your **NEXT** choice? **Place your answer in the NEXT box of the answer sheet, and proceed to that BLOCK NUMBER for further instructions.**

ACTION:

ANSWER BLOCK

- | | |
|---|---|
| • LISTEN TO FUEL PUMP OPERATION | 6 |
| • TALK WITH DRIVER OF VEHICLE | 2 |
| • REMOVE OIL PAN AND CHECK ALL BEARINGS | 9 |
| • PERFORM EVALUATION ON COLD VEHICLE | 5 |

BLOCK NUMBER 2

After questioning the driver of the vehicle it is discovered that the knock is present only during a cold engine start-up. The knock slowly diminishes as the vehicle warms up. Of the **ACTIONS** listed below, which would be your **NEXT** choice? **Place your answer in the NEXT box of the answer sheet, and proceed to that BLOCK NUMBER for further instructions.**

ACTION:

ANSWER BLOCK

- | | |
|--|---|
| • PERFORM EVALUATION ON COLD VEHICLE | 5 |
| • LISTEN TO FUEL PUMP OPERATION | 6 |
| • REMOVE VALVE COVER AND INSPECT VALVE TRAIN | 8 |
| • REMOVE AND DISASSEMBLE ENGINE FOR INSPECTION | 7 |

BLOCK NUMBER 3

An inspection under the hood reveals that all components are connected securely. Nothing appears unusual. Fluid levels were not verified. Of the **ACTIONS** listed below, which would be your **NEXT** choice? **Place your answer in the NEXT box of the answer sheet, and proceed to that BLOCK NUMBER for further instructions.**

ACTION:

ANSWER BLOCK

- CHECK ENGINE OIL LEVEL 4
- REMOVE AND DISASSEMBLE ENGINE FOR INSPECTION 7
- REMOVE VALVE COVER AND INSPECT VALVE TRAIN 8
- REMOVE OIL PAN AND CHECK ALL BEARINGS 9

BLOCK NUMBER 4

A check has been made of the fluid levels. All levels are to specification and oil quality appears good. Of the **ACTIONS** listed below, which would be your **NEXT** choice? **Place your answer in the NEXT box of the answer sheet, and proceed to that BLOCK NUMBER for further instructions.**

ACTION:

ANSWER BLOCK

- REMOVE VALVE COVER AND INSPECT VALVE TRAIN 8
- REMOVE OIL PAN AND CHECK ALL BEARINGS 9
- REMOVE AND DISASSEMBLE ENGINE FOR INSPECTION 7
- TEST DRIVE VEHICLE 1

BLOCK NUMBER 5

You have elected to test the vehicle while it is cold. It has been allowed to cool in the service parking area all night. Upon start-up the next morning, engine knock is heard. The vehicle is immediately brought into the service bay and shut off. Of the **ACTIONS** listed below, which would be your **NEXT** choice? **Place your answer in the NEXT box of the answer sheet, and proceed to that BLOCK NUMBER for further instructions.**

ACTION:

ANSWER BLOCK

- REPLACE OIL PUMP ASSEMBLY 12
- REMOVE AND DISASSEMBLE ENGINE FOR INSPECTION 7
- LISTEN TO FUEL PUMP OPERATION 6
- PERFORM CYLINDER BALANCE WITH SCOPE TO ISOLATE PROBLEM CYLINDER 10

DIAGNOSIS EXERCISES

BLOCK NUMBER 6

You have elected to listen to the fuel pump while the engine is still cold. The knock does not seem to originate from the fuel pump. Of the **ACTIONS** listed below, which would be your **NEXT** choice? **Place your answer in the NEXT box of the answer sheet, and proceed to that BLOCK NUMBER for further instructions.**

ACTION:

ANSWER BLOCK

- REMOVE OIL PAN AND CHECK ALL BEARINGS 9
- PERFORM CYLINDER BALANCE WITH SCOPE TO ISOLATE PROBLEM CYLINDER 10
- REMOVE VALVE COVER AND INSPECT VALVE TRAIN 8
- REMOVE AND DISASSEMBLE ENGINE FOR INSPECTION 7

BLOCK NUMBER 7

You have elected to remove and disassemble the engine. All internal components are visually inspected. Everything appears to have been assembled correctly. Of the **ACTIONS** listed below, which would be your **NEXT** choice? **Place your answer in the NEXT box of the answer sheet, and proceed to that BLOCK NUMBER for further instructions.**

ACTION:

ANSWER BLOCK

- REMOVE VALVE COVER AND INSPECT VALVE TRAIN 8
- REPLACE OIL PUMP ASSEMBLY 12
- REPLACE ALL ENGINE LOWER BEARINGS AND RE-EVALUATE 11
- DISASSEMBLE TRANSMISSION FOR INSPECTION 16

BLOCK NUMBER 8

After removing the valve cover and inspecting the valve train, there appear to be no faults. Of the **ACTIONS** listed below, which would be your **NEXT** choice? **Place your answer in the NEXT box of the answer sheet, and proceed to that BLOCK NUMBER for further instructions.**

ACTION:

ANSWER BLOCK

- REPLACE OIL PUMP ASSEMBLY 12
- REMOVE AND DISASSEMBLE ENGINE FOR INSPECTION 7
- REPLACE ALL ENGINE LOWER BEARINGS AND RE-EVALUATE 11
- DISASSEMBLE TRANSMISSION FOR INSPECTION 16

DIAGNOSIS EXERCISES

BLOCK NUMBER 9

You have elected to remove the oil pan and replace all of the lower engine gearings. This repair has not affected the condition. Of the **ACTIONS** listed below, which would be your **NEXT** choice? **Place your answer in the NEXT box of the answer sheet, and proceed to that BLOCK NUMBER for further instructions.**

ACTION:

ANSWER BLOCK

- | | |
|--|----|
| • REPLACE OIL PUMP ASSEMBLY | 12 |
| • DISASSEMBLE TRANSMISSION FOR INSPECTION | 16 |
| • REMOVE CAMSHAFT FOR INSPECTION | 15 |
| • REPLACE ALL ENGINE LOWER BEARINGS
AND RE-EVALUATE | 11 |

BLOCK NUMBER 10

An evaluation with an engine analyzer has been made. It is found that when cylinder No. four is shorted during the cylinder balance test, the noise suddenly stops. Of the **ACTIONS** listed below, which would be your **NEXT** choice? **Place your answer in the NEXT box of the answer sheet, and proceed to that BLOCK NUMBER for further instructions.**

ACTION:

ANSWER BLOCK

- | | |
|--|----|
| • REMOVE CYLINDER HEAD AND OIL PAN | 14 |
| • REPLACE OIL PUMP ASSEMBLY | 12 |
| • REMOVE CAMSHAFT FOR INSPECTION | 15 |
| • REPLACE ALL ENGINE LOWER BEARINGS
AND RE-EVALUATE | 11 |

BLOCK NUMBER 11

You have elected to replace all of the lower engine bearings. After doing so, the noise is still present. Of the **ACTIONS** listed below, which would be your **NEXT** choice? **Place your answer in the NEXT box of the answer sheet, and proceed to that BLOCK NUMBER for further instructions.**

ACTION:

ANSWER BLOCK

- | | |
|---|----|
| • REPLACE OIL PUMP ASSEMBLY | 12 |
| • REMOVE CAMSHAFT FOR INSPECTION | 15 |
| • DISASSEMBLE TRANSMISSION FOR INSPECTION | 16 |

DIAGNOSIS EXERCISES

BLOCK NUMBER 12

You have elected to replace the engine oil pump. A diagnostic test is available to determine if the pump is damaged. At this point, too much time has been spent on the vehicle. There is nothing wrong with the oil pump. Remember, exhaust all the easy quick checks before proceeding to the more difficult ones. Using the answer key, follow the block sequence to determine the correct diagnostic path.

BLOCK NUMBER 13

Your diagnosis has led you to believe there may be a component out of specifications. After measuring the components you discover the piston is not to specification. The problem has been solved! Now that you have completed this exercise, continue to exercise VII. Vehicle Concern: Engine Cranks But Won't Start.

BLOCK NUMBER 14

You have elected to visually inspect the components related to cylinder No. four. There is no external damage. Of the **ACTIONS** listed below, which would be your **NEXT** choice? **Place your answer in the NEXT box of the answer sheet, and proceed to that BLOCK NUMBER for further instructions.**

ACTION:

- CHECK NUMBER FOUR CYLINDER COMPONENTS (PISTON, ROD, WRIST PIN, ETC.)
- INSTALL NEW ROD BEARING AND WRIST PIN—REASSEMBLE AND TRY AGAIN

ANSWER BLOCK

13

17

BLOCK NUMBER 15

You have elected to remove the camshaft for inspection. At this point, too much time has been spent on the vehicle. There is nothing wrong with the camshaft. Remember, exhaust all the easy quick checks before proceeding to the more difficult ones. Using the answer key, follow the block sequence to determine the correct diagnostic path.

BLOCK NUMBER 16

You have elected to remove and disassemble the transmission. At this point, too much time has been spent on the vehicle. There is nothing wrong with the transmission. Remember, exhaust all the easy quick checks before proceeding to the more difficult ones. Using the answer key, follow the block sequence to determine the correct diagnostic path.

BLOCK NUMBER 17

You have elected to replace only the rod bearing and the wrist pin for cylinder No. four. At this point, too much time has been spent on the vehicle. There is nothing wrong with these components. Remember, a measurement of these components will determine if they are faulty or not. Exhaust all the easy quick checks before proceeding to the more difficult ones. Using the answer key, follow the block sequence to determine the correct diagnostic path.

DIAGNOSIS EXERCISES

VI. VEHICLE CONCERN: ENGINE NOISE/KNOCKS

ANSWER SHEET

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NOTE: Enter your answers from left to right! Remember, you might not use all of the answer squares.

SEE ANSWER KEY ON PAGE 132

DIAGNOSIS EXERCISES

VII. VEHICLE CONCERN: ENGINE CRANKS BUT WON'T START

The following are **ACTIONS** that you may choose to correct the cause of the concern. Remember, choose only one action. Study the choices and once you have determined what you would do first, place that answer in the **first** box of the answer sheet. Then, proceed to that specific **BLOCK NUMBER** for further instructions.

ACTION:

- PERFORM VISUAL UNDER-HOOD INSPECTION
- CHECK IGNITION FOR SPARK
- VERIFY ENGINE IS RECEIVING FUEL
- REPLACE IGNITION MODULE

ANSWER BLOCK

- 1
- 2
- 3
- 4

BLOCK NUMBER 1

A visual inspection of the under-hood components reveals components are connected properly. Of the **ACTIONS** listed below, which would be your **NEXT** choice? **Place your answer in the NEXT box of the answer sheet, and proceed to that BLOCK NUMBER for further instructions.**

ACTION:

- CHECK IGNITION FOR SPARK
- REPLACE IGNITION MODULE
- VERIFY ENGINE IS RECEIVING FUEL
- CHECK SPARK PLUGS FOR FOULING

ANSWER BLOCK

- 2
- 4
- 3
- 5

BLOCK NUMBER 2

A quick check of the ignition system reveals that the coil is producing spark. Also, high secondary voltage is available to the spark plugs. Of the **ACTIONS** listed below, which would be your **NEXT** choice? **Place your answer in the NEXT box of the answer sheet, and proceed to that BLOCK NUMBER for further instructions.**

ACTION:

- PERFORM VISUAL UNDER-HOOD INSPECTION
- REPLACE IGNITION MODULE
- REMOVE DISTRIBUTOR AND CHECK DRIVE GEAR
- VERIFY ENGINE IS RECEIVING FUEL

ANSWER BLOCK

- 1
- 4
- 6
- 3

DIAGNOSIS EXERCISES

BLOCK NUMBER 3

You have elected to determine if fuel is available to the engine. Although an entire fuel system evaluation was not performed, you are positive that the engine is receiving acceptable fuel to start. Of the **ACTIONS** listed below, which would be your **NEXT** choice? **Place your answer in the NEXT box of the answer sheet, and proceed to that BLOCK NUMBER for further instructions.**

ACTION:

ANSWER BLOCK

- | | |
|---|---|
| • CHECK SPARK PLUGS FOR FOULING | 5 |
| • CHECK IGNITION FOR SPARK | 2 |
| • CHECK CYLINDER COMPRESSION | 8 |
| • REMOVE DISTRIBUTOR AND CHECK DRIVE GEAR | 6 |

BLOCK NUMBER 4

You have elected to replace the ignition module. The vehicle still will not start. Of the **ACTIONS** listed below, which would be your **NEXT** choice? **Place your answer in the NEXT box of the answer sheet, and proceed to that BLOCK NUMBER for further instructions.**

ACTION:

ANSWER BLOCK

- | | |
|---|---|
| • VERIFY ENGINE IS RECEIVING FUEL | 3 |
| • REMOVE DISTRIBUTOR AND CHECK DRIVE GEAR | 6 |
| • REMOVE CAMSHAFT FOR INSPECTION | 7 |
| • CHECK SPARK PLUGS FOR FOULING | 5 |

BLOCK NUMBER 5

You have elected to remove the spark plugs to check for fouling. The plugs are acceptable. Of the **ACTIONS** listed below, which would be your **NEXT** choice? **Place your answer in the NEXT box of the answer sheet, and proceed to that BLOCK NUMBER for further instructions.**

ACTION:

ANSWER BLOCK

- | | |
|---|----|
| • CHECK CYLINDER COMPRESSION | 8 |
| • REPLACE FUEL PUMP | 9 |
| • REPLACE SPARK PLUGS | 14 |
| • REMOVE DISTRIBUTOR AND CHECK DRIVE GEAR | 6 |

DIAGNOSIS EXERCISES

BLOCK NUMBER 6

The distributor has been removed from the engine. There is no problem with the distributor. Of the **ACTIONS** listed below, which would be your **NEXT** choice? **Place your answer in the NEXT box of the answer sheet, and proceed to that BLOCK NUMBER for further instructions.**

ACTION:

- CHECK SPARK PLUGS FOR FOULING
- REPLACE FUEL PUMP
- CHECK CYLINDER COMPRESSION
- REMOVE CAMSHAFT FOR INSPECTION

ANSWER BLOCK

5
9
8
7

BLOCK NUMBER 7

You have elected to remove the camshaft for inspection. At this point, too much time has been spent on the vehicle. There is nothing wrong with the camshaft. Remember, exhaust all the easy quick checks before proceeding to the more difficult ones. Using the answer key, follow the block sequence to determine the correct diagnostic path.

BLOCK NUMBER 8

You have elected to check engine compression. The highest reading is 50 psi. The test is repeated and the results are the same, wet or dry. Of the **ACTIONS** listed below, which would be your **NEXT** choice? **Place your answer in the NEXT box of the answer sheet, and proceed to that BLOCK NUMBER for further instructions.**

ACTION:

- INSPECT CAMSHAFT DRIVE SYSTEM
- REPLACE PISTON RINGS
- RETEST WITH NEW COMPRESSION GAUGE
- REMOVE CAMSHAFT FOR INSPECTION

ANSWER BLOCK

11
10
15
7

BLOCK NUMBER 9

You have elected to replace the fuel pump. At this point, too much time has been spent on the vehicle. There is nothing wrong with the fuel system. Remember, exhaust all the easy quick checks before proceeding to the more difficult ones. Using the answer key, follow the block sequence to determine the correct diagnostic path.

DIAGNOSIS EXERCISES

BLOCK NUMBER 10

You have elected to replace the piston rings. At this point, too much time has been spent on the vehicle. There is nothing wrong with the piston rings. Remember, exhaust all the easy quick checks before proceeding to the more difficult ones. Using the answer key, follow the block sequence to determine the correct diagnostic path.

BLOCK NUMBER 11

You have elected to remove the camshaft drive cover. The drive system is loose but not broken. Of the **ACTIONS** listed below, which would be your **NEXT** choice? **Place your answer in the NEXT box of the answer sheet, and proceed to that BLOCK NUMBER for further instructions.**

ACTION:

ANSWER BLOCK

- | | |
|-------------------------------------|----|
| • CHECK CAMSHAFT TIMING | 13 |
| • INSTALL TIMING COVER | 16 |
| • REPLACE CAMSHAFT DRIVE COMPONENTS | 12 |

BLOCK NUMBER 12

You have elected to replace the camshaft drive system components. This is the correct diagnosis. After proper assembly, the vehicle is repaired! Now that you have completed this exercise, continue to exercise VIII. Vehicle Concern: Spark Knock/Pinging.

BLOCK NUMBER 13

A test of the camshaft drive timing has been performed. The timing is incorrect. Of the **ACTIONS** listed below, which would be your **NEXT** choice? **Place your answer in the NEXT box of the answer sheet, and proceed to that BLOCK NUMBER for further instructions.**

ACTION:

ANSWER BLOCK

- | | |
|-------------------------------------|----|
| • REPLACE CAMSHAFT DRIVE COMPONENTS | 12 |
| • INSTALL TIMING COVER | 16 |

BLOCK NUMBER 14

You have elected to replace the spark plugs. At this point, too much time has been spent on the vehicle. There is nothing wrong with the spark plugs. Remember, exhaust all the easy quick checks before proceeding to the more difficult ones. Using the answer key, follow the block sequence to determine the correct diagnostic path.

BLOCK NUMBER 15

You have elected to recheck the compression readings with a different gauge. Proceed to block number eight (8).

BLOCK NUMBER 16

You have elected to install the timing cover. At this point, too much time has been spent on the vehicle. You have not properly diagnosed the concern. Using the answer key, follow the block sequence to determine the correct diagnostic path.

DIAGNOSIS EXERCISES

VII. VEHICLE CONCERN: ENGINE CRANKS BUT WON'T START

ANSWER SHEET

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NOTE: Enter your answers from left to right! Remember, you might not use all of the answer squares.

VIII. VEHICLE CONCERN: SPARK KNOCK/PINGING

The following are **ACTIONS** that you may choose to correct the cause of the concern. Remember, choose only one action. Study the choices and once you have determined what you would do first, place your answer in the **first** box of the answer sheet. Then, proceed to that specific **BLOCK NUMBER** for further instructions.

ACTION:

- PERFORM VISUAL UNDER-HOOD INSPECTION
- TEST DRIVE VEHICLE
- CHECK AND ADJUST IGNITION TIMING
- RETURN VEHICLE TO CUSTOMER, NO PROBLEM FOUND

ANSWER BLOCK

- 1
- 2
- 3
- 4

BLOCK NUMBER 1

An inspection under the hood reveals that a few EGR vacuum lines may not have been properly connected. You make the proper connections. Of the **ACTIONS** listed below, which would be your **NEXT** choice? **Place your answer in the NEXT box of the answer sheet, and proceed to that BLOCK NUMBER for further instructions.**

ACTION:

- CHECK ENGINE FOR VACUUM LEAKS
- CHECK AND ADJUST IGNITION TIMING
- RETURN VEHICLE TO CUSTOMER, NO PROBLEM FOUND
- TEST DRIVE VEHICLE

ANSWER BLOCK

- 5
- 3
- 4
- 2

BLOCK NUMBER 2

A vehicle test drive does not initially indicate a spark knock. As the vehicle nears operating temperature, pinging is detected. The knock occurs during cruise and acceleration. Of the **ACTIONS** listed below, which would be your **NEXT** choice? **Place your answer in the NEXT box of the answer sheet, and proceed to that BLOCK NUMBER for further instructions.**

ACTION:

- CHECK CYLINDER COMPRESSION
- EVALUATE COOLING SYSTEM OPERATION
- RETURN VEHICLE TO CUSTOMER, NO PROBLEM FOUND
- CHECK AND ADJUST IGNITION TIMING

ANSWER BLOCK

- 8
- 10
- 4
- 3

DIAGNOSIS EXERCISES

BLOCK NUMBER 3

A check of ignition timing reveals timing is to specification. Advance is also correct. Of the **ACTIONS** listed below, which would be your **NEXT** choice? **Place your answer in the NEXT box of the answer sheet, and proceed to that BLOCK NUMBER for further instructions.**

ACTION:

- VERIFY CORRECT EGR APPLICATION
- VERIFY PROPER VACUUM ROUTING
- REPLACE IGNITION MODULE
- RETURN VEHICLE TO CUSTOMER, NO PROBLEM FOUND

ANSWER BLOCK

6
7
11
4

BLOCK NUMBER 4

You have advised the owner of the vehicle that the problem could be fuel related, indicating high octane fuel may correct the problem. However, the owner has been using only high octane fuel. The problem still exists. Of the **ACTIONS** listed below, which would be your **NEXT** choice? **Place your answer in the NEXT box of the answer sheet, and proceed to that BLOCK NUMBER for further instructions.**

ACTION:

- PERFORM VISUAL UNDER-HOOD INSPECTION
- TEST DRIVE VEHICLE
- CHECK AND ADJUST IGNITION TIMING

ANSWER BLOCK

1
2
3

BLOCK NUMBER 5

You have determined that the engine may have a vacuum leak. After a visual inspection and a manifold vacuum test, no such problem is found. Of the **ACTIONS** listed below, which would be your **NEXT** choice? **Place your answer in the NEXT box of the answer sheet, and proceed to that BLOCK NUMBER for further instructions.**

ACTION:

- EVALUATE COOLING SYSTEM OPERATION
- REPLACE IGNITION MODULE
- VERIFY PROPER VACUUM ROUTING
- PERFORM EGR SYSTEM DIAGNOSIS

ANSWER BLOCK

10
11
7
9

DIAGNOSIS EXERCISES

BLOCK NUMBER 6

A check of the EGR application has been performed. The EGR calibration is correct for the engine. Of the **ACTIONS** listed below, which would be your **NEXT** choice? Place your answer in the **NEXT** box of the answer sheet, and proceed to that **BLOCK NUMBER** for further instructions.

ACTION:	ANSWER BLOCK
• PERFORM EGR SYSTEM DIAGNOSIS	9
• EVALUATE COOLING SYSTEM OPERATION	10
• CHECK CYLINDER COMPRESSION	8
• RETURN VEHICLE TO CUSTOMER, NO PROBLEM FOUND	4

BLOCK NUMBER 7

You have elected to verify proper vacuum line routing. According to the under-hood vacuum schematic the routing is correct. Of the **ACTIONS** listed below, which would be your **NEXT** choice? Place your answer in the **NEXT** box of the answer sheet, and proceed to that **BLOCK NUMBER** for further instructions.

ACTION:	ANSWER BLOCK
• RETURN VEHICLE TO CUSTOMER, NO PROBLEM FOUND	4
• EVALUATE COOLING SYSTEM OPERATION	10
• CLEAN CARBON FROM COMBUSTION CHAMBER	12
• CHECK CYLINDER COMPRESSION	8

BLOCK NUMBER 8

A compression test reveals that the cylinders are even and to specification. Of the **ACTIONS** listed below, which would be your **NEXT** choice? Place your answer in the **NEXT** box of the answer sheet, and proceed to that **BLOCK NUMBER** for further instructions.

ACTION:	ANSWER BLOCK
• EVALUATE COOLING SYSTEM OPERATION	10
• CLEAN CARBON FROM COMBUSTION CHAMBER	12
• REPLACE IGNITION MODULE	11
• RETURN VEHICLE TO CUSTOMER, NO PROBLEM FOUND	4

BLOCK NUMBER 9

You have elected to test the EGR system. The system is operating according to the Shop Manual. Of the **ACTIONS** listed below, which would be your **NEXT** choice? Place your answer in the **NEXT** box of the answer sheet, and proceed to that **BLOCK NUMBER** for further instructions.

ACTION:	ANSWER BLOCK
• CHECK AIR INDUCTION SYSTEM FOR RESTRICTION	13
• RETURN VEHICLE TO CUSTOMER, NO PROBLEM FOUND	4
• VERIFY PROPER VACUUM ROUTING	7
• EVALUATE COOLING SYSTEM OPERATION	10

DIAGNOSIS EXERCISES

BLOCK NUMBER 10

An evaluation of the cooling system indicates proper operation. The engine is not overheating and the instrument gauge is functioning. Of the **ACTIONS** listed below, which would be your **NEXT** choice? Place your answer in the **NEXT** box of the answer sheet, and proceed to that **BLOCK NUMBER** for further instructions.

ACTION:

ANSWER BLOCK

- | | |
|--|----|
| • PERFORM EGR SYSTEM DIAGNOSIS | 9 |
| • RETURN VEHICLE TO CUSTOMER, NO PROBLEM FOUND | 4 |
| • REPLACE HALL EFFECT DEVICE | 14 |
| • REPLACE IGNITION MODULE | 11 |

BLOCK NUMBER 11

You have elected to replace the ignition module. At this point, too much time has been spent on the vehicle. There is nothing wrong with the ignition module. Remember, replace parts that are proved faulty. Using the answer key, follow the block sequence to determine the correct diagnostic path.

BLOCK NUMBER 12

You have elected to clean carbon from the combustion chamber. At this point, too much time has been spent on the vehicle. There is nothing wrong with the combustion chamber. Remember, exhaust all the easy quick checks before proceeding to the more difficult ones. Using the answer key, follow the block sequence to determine the correct diagnostic path.

BLOCK NUMBER 13

You have elected to test the performance of the air induction preheat system. This is the cause of your problem. The air cleaner vacuum door is stuck in the heat position due to damage! The problem has been diagnosed. Now that you have completed this exercise, continue to exercise IX. Vehicle Concern: Hesitates and Stalls on Acceleration.

BLOCK NUMBER 14

You have elected to replace the Hall effect device. At this point, too much time has been spent on the vehicle. There is nothing wrong with the Hall effect device. Remember, the part should be replaced only if it is damaged. Using the answer key, follow the block sequence to determine the correct diagnostic path.

DIAGNOSIS EXERCISES

VIII. VEHICLE CONCERN: SPARK KNOCK/PINGING

ANSWER SHEET

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NOTE: Enter your answers from left to right! Remember, you might not use all of the answer squares.

SEE ANSWER KEY ON PAGE 133

DIAGNOSIS EXERCISES

IX. VEHICLE CONCERN: HESITATES AND STALLS ON ACCELERATION

The following are **ACTIONS** that you may choose to correct the cause of the concern. Remember, choose only one action. Study the choices and once you have determined what you would do first, place your answer in the **first** box of the answer sheet. Then, proceed to that specific **BLOCK NUMBER** for further instructions.

ACTION:	ANSWER BLOCK
• TEST DRIVE VEHICLE	1
• PERFORM VISUAL UNDER-HOOD INSPECTION	2
• CHECK EGR VALVE AND VACUUM CONNECTION	3
• CHECK AND ADJUST IGNITION TIMING	4

BLOCK NUMBER 1

You have elected to test drive the vehicle. It has been parked in the service parking area all night. The vehicle starts without a problem but hesitates and stalls on acceleration. As the vehicle warms up, the problem disappears. Once the vehicle is fully warm the problem is gone. Of the **ACTIONS** listed below, which would be your **NEXT** choice? **Place your answer in the NEXT box of the answer sheet, and proceed to that BLOCK NUMBER for further instructions.**

ACTION:	ANSWER BLOCK
• PERFORM EGR SYSTEM DIAGNOSIS	7
• PERFORM FUEL SYSTEM DIAGNOSIS	8
• TEST IGNITION WITH ENGINE ANALYZER	6
• CHECK FOR PROPER ACCELERATION FUEL DELIVERY	5

BLOCK NUMBER 2

A visual inspection under the hood indicates everything is connected and routed properly. Of the **ACTIONS** listed below, which would be your **NEXT** choice? **Place your answer in the NEXT box of the answer sheet, and proceed to that BLOCK NUMBER for further instructions.**

ACTION:	ANSWER BLOCK
• TEST DRIVE VEHICLE	1
• TEST IGNITION WITH ENGINE ANALYZER	6
• PERFORM EGR SYSTEM DIAGNOSIS	7
• CHECK EGR VALVE AND VACUUM CONNECTION	3

DIAGNOSIS EXERCISES

BLOCK NUMBER 3

You have elected to check the EGR valve. It is connected and does not appear damaged. Of the **ACTIONS** listed below, which would be your **NEXT** choice? **Place your answer in the NEXT box of the answer sheet, and proceed to that BLOCK NUMBER for further instructions.**

ACTION:

ANSWER BLOCK

- PERFORM VISUAL UNDER-HOOD INSPECTION
- TEST IGNITION WITH ENGINE ANALYZER
- PERFORM FUEL SYSTEM DIAGNOSIS
- CHECK AND ADJUST IGNITION TIMING

2
6
8
4

BLOCK NUMBER 4

A check of ignition timing determines that it is within specification. Of the **ACTIONS** listed below, which would be your **NEXT** choice? **Place your answer in the NEXT box of the answer sheet, and proceed to that BLOCK NUMBER for further instructions.**

ACTION:

ANSWER BLOCK

- TEST DRIVE VEHICLE
- PERFORM EGR SYSTEM DIAGNOSIS
- TEST IGNITION WITH ENGINE ANALYZER
- PERFORM FUEL SYSTEM DIAGNOSIS

1
7
6
8

BLOCK NUMBER 5

You have elected to verify acceleration fuel delivery. The engine is receiving sufficient fuel. Of the **ACTIONS** listed below, which would be your **NEXT** choice? **Place your answer in the NEXT box of the answer sheet, and proceed to that BLOCK NUMBER for further instructions.**

ACTION:

ANSWER BLOCK

- CHECK AIR CLEANER VACUUM DOOR
- PERFORM EGR SYSTEM DIAGNOSIS
- PERFORM ENGINE TUNE-UP
- TEST IGNITION WITH ENGINE ANALYZER

9
7
12
6

DIAGNOSIS EXERCISES

BLOCK NUMBER 6

An engine analyzer test of the ignition system reveals normal operation. Of the **ACTIONS** listed below, which would be your **NEXT** choice? **Place your answer in the NEXT box of the answer sheet, and proceed to that BLOCK NUMBER for further instructions.**

ACTION:

- VERIFY PROPER VACUUM ROUTING
- PERFORM FUEL SYSTEM DIAGNOSIS
- OVERHAUL FUEL METERING SYSTEM
- PERFORM EGR SYSTEM DIAGNOSIS

ANSWER BLOCK

- 13
- 8
- 11
- 7

BLOCK NUMBER 7

You have elected to evaluate the EGR system. It is operating properly according to the Shop Manual testing procedures. Of the **ACTIONS** listed below, which would be your **NEXT** choice? **Place your answer in the NEXT box of the answer sheet, and proceed to that BLOCK NUMBER for further instructions.**

ACTION:

- TEST IGNITION WITH ENGINE ANALYZER
- OVERHAUL FUEL METERING SYSTEM
- VERIFY PROPER VACUUM ROUTING
- PERFORM FUEL SYSTEM DIAGNOSIS

ANSWER BLOCK

- 6
- 11
- 13
- 8

BLOCK NUMBER 8

A fuel delivery system evaluation has determined no malfunctions. Of the **ACTIONS** listed below, which would be your **NEXT** choice? **Place your answer in the NEXT box of the answer sheet, and proceed to that BLOCK NUMBER for further instructions.**

ACTION:

- TEST IGNITION WITH ENGINE ANALYZER
- VERIFY PROPER VACUUM ROUTING
- PERFORM ENGINE TUNE-UP
- OVERHAUL FUEL METERING SYSTEM

ANSWER BLOCK

- 6
- 13
- 12
- 11

BLOCK NUMBER 9

A check of the air cleaner vacuum door indicates proper operation when vacuum is applied with a hand pump. Of the **ACTIONS** listed below, which would be your **NEXT** choice? **Place your answer in the NEXT box of the answer sheet, and proceed to that BLOCK NUMBER for further instructions.**

ACTION:

- PERFORM ENGINE TUNE-UP
- PERFORM EGR SYSTEM DIAGNOSIS
- OVERHAUL FUEL METERING SYSTEM
- TEST AIR CLEANER VACUUM DOOR CONTROL SYSTEM

ANSWER BLOCK

- 12
- 7
- 11
- 10

BLOCK NUMBER 10

A test of the air cleaner vacuum door thermal control system reveals that it is inoperative. The problem has been found! Now that you have completed this exercise, continue to exercise X. Vehicle Concern: Poor Vehicle Performance/Dies on Acceleration.

BLOCK NUMBER 11

You have elected to overhaul the fuel metering system. At this point, too much time has been spent on the vehicle. There is nothing wrong with the fuel system. Remember, exhaust all the easy quick checks before proceeding to the more difficult ones. Using the answer key, follow the block sequence to determine the correct diagnostic path.

BLOCK NUMBER 12

You have elected to perform an engine tune-up. At this point, too much time has been spent on the vehicle. A tune-up is not necessary. Remember, exhaust all the easy quick checks before proceeding to the more difficult ones. Using the answer key, follow the block sequence to determine the correct diagnostic path.

BLOCK NUMBER 13

You have elected to check the entire vacuum system routing. At this point, too much time has been spent on the vehicle. There is nothing wrong with the vacuum system routing. Remember, exhaust all the easy quick checks before proceeding to the more difficult ones. Using the answer key, follow the block sequence to determine the correct diagnostic path.

DIAGNOSIS EXERCISES

IX. VEHICLE CONCERN: HESITATES AND STALLS ON ACCELERATION

ANSWER SHEET

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NOTE: Enter your answers from left to right! Remember, you might not use all of the answer squares.

X. VEHICLE CONCERN: POOR VEHICLE PERFORMANCE/DIES ON ACCELERATION

The following are **ACTIONS** that you may choose to correct the cause of the concern. Remember, choose only one action. Study the choices and once you have determined what you would do first, place your answer in the **first** box of the answer sheet. Then, proceed to that specific **BLOCK NUMBER** for further instructions.

ACTION:

ANSWER BLOCK

- PERFORM ENGINE TUNE-UP
- PERFORM VISUAL UNDER-HOOD INSPECTION
- TEST DRIVE VEHICLE
- REPLACE FUEL FILTER

1
2
3
4

BLOCK NUMBER 1

You have elected to tune the engine on this vehicle. After doing so, the problem still exists. Of the **ACTIONS** listed below, which would be your **NEXT** choice? Place your answer in the **NEXT** box of the answer sheet, and proceed to that **BLOCK NUMBER** for further instructions.

ACTION:

ANSWER BLOCK

- TALK WITH DRIVER OF VEHICLE
- CHECK CYLINDER COMPRESSION
- REPLACE AIR FILTER ELEMENT
- REPLACE FUEL FILTER

5
6
9
4

BLOCK NUMBER 2

An under-hood visual inspection reveals nothing. All components are connected and nothing unusual is noted. Of the **ACTIONS** listed below, which would be your **NEXT** choice? Place your answer in the **NEXT** box of the answer sheet, and proceed to that **BLOCK NUMBER** for further instructions.

ACTION:

ANSWER BLOCK

- CHECK AND ADJUST IGNITION TIMING
- CHECK CYLINDER COMPRESSION
- TALK WITH DRIVER OF VEHICLE
- TEST DRIVE VEHICLE

7
6
5
3

DIAGNOSIS EXERCISES

BLOCK NUMBER 3

A vehicle test drive is performed. The vehicle performs normally. Of the **ACTIONS** listed below, which would be your **NEXT** choice? Place your answer in the **NEXT** box of the answer sheet, and proceed to that **BLOCK NUMBER** for further instructions.

ACTION:

- TALK WITH DRIVER OF VEHICLE
- TEST DRIVE VEHICLE
- PERFORM VISUAL CHECK EXHAUST SYSTEM
- CHECK AND ADJUST IGNITION TIMING

ANSWER BLOCK

5
3
8
7

BLOCK NUMBER 4

You have elected to replace the fuel filter. The original filter did not appear to be faulty. Of the **ACTIONS** listed below, which would be your **NEXT** choice? Place your answer in the **NEXT** box of the answer sheet, and proceed to that **BLOCK NUMBER** for further instructions.

ACTION:

- CHECK AND ADJUST IGNITION TIMING
- PERFORM VISUAL CHECK OF EXHAUST SYSTEM
- CHECK CYLINDER COMPRESSION
- REPLACE AIR FILTER ELEMENT

ANSWER BLOCK

7
8
6
9

BLOCK NUMBER 5

A discussion with the driver of the vehicle reveals that the problem occurs only while the vehicle is towing a trailer up grades and during periods of heavy demand. Of the **ACTIONS** listed below, which would be your **NEXT** choice? Place your answer in the **NEXT** box of the answer sheet, and proceed to that **BLOCK NUMBER** for further instructions.

ACTION:

- REPLACE AIR FILTER ELEMENT
- CHECK CYLINDER COMPRESSION
- PERFORM EGR SYSTEM DIAGNOSIS
- TEST DRIVE UNDER LOAD

ANSWER BLOCK

9
6
11
10

DIAGNOSIS EXERCISES

BLOCK NUMBER 6

You have elected to check the compression of the engine. Doing so reveals that the compression is normal. Of the **ACTIONS** listed below, which would be your **NEXT** choice? Place your answer in the **NEXT** box of the answer sheet, and proceed to that **BLOCK NUMBER** for further instructions.

ACTION:

ANSWER BLOCK

- | | |
|--|----|
| • REPLACE AIR FILTER ELEMENT | 9 |
| • PERFORM EGR SYSTEM DIAGNOSIS | 11 |
| • PERFORM VISUAL CHECK OF EXHAUST SYSTEM | 8 |
| • CHECK AND ADJUST IGNITION TIMING | 7 |

BLOCK NUMBER 7

A check of the ignition timing reveals that it is exactly to specification. Of the **ACTIONS** listed below, which would be your **NEXT** choice? Place your answer in the **NEXT** box of the answer sheet, and proceed to that **BLOCK NUMBER** for further instructions.

ACTION:

ANSWER BLOCK

- | | |
|--|----|
| • PERFORM EGR SYSTEM DIAGNOSIS | 11 |
| • REPLACE AIR FILTER ELEMENT | 9 |
| • REPLACE FUEL PUMP | 14 |
| • PERFORM VISUAL CHECK OF EXHAUST SYSTEM | 8 |

BLOCK NUMBER 8

An inspection of the exhaust system reveals no external damage. Of the **ACTIONS** listed below, which would be your **NEXT** choice? Place your answer in the **NEXT** box of the answer sheet, and proceed to that **BLOCK NUMBER** for further instructions.

ACTION:

ANSWER BLOCK

- | | |
|------------------------------------|----|
| • TEST FUEL FLOW FROM FUEL TANK | 12 |
| • CHECK AND ADJUST IGNITION TIMING | 7 |
| • PERFORM EGR SYSTEM DIAGNOSIS | 11 |
| • REPLACE AIR FILTER ELEMENT | 9 |

DIAGNOSIS EXERCISES

BLOCK NUMBER 9

You have elected to replace the air filter. This action has had no effect on the engine. Of the **ACTIONS** listed below, which would be your **NEXT** choice? **Place your answer in the NEXT box of the answer sheet, and proceed to that BLOCK NUMBER for further instructions.**

ACTION:

ANSWER BLOCK

- | | |
|--|----|
| • REPLACE FUEL FILTER | 16 |
| • RETURN VEHICLE TO CUSTOMER, NO PROBLEM FOUND | 17 |
| • REPLACE FUEL PUMP | 14 |

BLOCK NUMBER 10

A test drive determines that the vehicle loses power while under severe load. The power loss is gradual and the engine never stalls. If the load is removed engine operation is normal. Of the **ACTIONS** listed below, which would be your **NEXT** choice? **Place your answer in the NEXT box of the answer sheet, and proceed to that BLOCK NUMBER for further instructions.**

ACTION:

ANSWER BLOCK

- | | |
|---|----|
| • PERFORM FUEL SYSTEM PRESSURE AND DELIVERY TESTS | 13 |
| • REPLACE FUEL PUMP | 14 |
| • REPLACE AIR FILTER ELEMENT | 9 |
| • PERFORM EGR SYSTEM DIAGNOSIS | 11 |

BLOCK NUMBER 11

You have elected to test the EGR system. Doing so reveals that it is operating properly. Of the **ACTIONS** listed below, which would be your **NEXT** choice? **Place your answer in the NEXT box of the answer sheet, and proceed to that BLOCK NUMBER for further instructions.**

ACTION:

ANSWER BLOCK

- | | |
|--|----|
| • REPLACE FUEL PUMP | 14 |
| • RETURN VEHICLE TO CUSTOMER, NO PROBLEM FOUND | 17 |
| • REPLACE FUEL FILTER | 16 |

BLOCK NUMBER 12

A test of the fuel flow from the fuel tank reveals a restriction in the tank. You have diagnosed the concern! After the in-tank filter has been replaced and contamination removed from the tank, the vehicle operates normally. Now that you have completed this exercise, continue to exercise XI. Vehicle Concern: Engine Cranks But Won't Start (Fuel Injection).

BLOCK NUMBER 13

You have elected to test fuel system pressure and delivery. The pressure is normal but delivery rate is slightly below specification. The test was performed at a location between the fuel filter and the pump. Of the **ACTIONS** listed below, which would be your **NEXT** choice? **Place your answer in the NEXT box of the answer sheet, and proceed to that BLOCK NUMBER for further instructions.**

ACTION:	ANSWER BLOCK
• REPLACE FUEL FILTER	16
• REPLACE FUEL PUMP	14
• PERFORM FUEL DELIVERY TEST AT FUEL PUMP	15

BLOCK NUMBER 14

You have elected to replace the fuel pump. At this point, too much time has been spent on the vehicle. There is nothing wrong with the fuel pump. Remember, exhaust all the easy quick checks before proceeding to the more difficult ones. Using the answer key, follow the block sequence to determine the correct diagnostic path.

BLOCK NUMBER 15

You have elected to perform the fuel delivery test **at the pump**. The flow rate is still below normal. Of the **ACTIONS** listed below, which would be your **NEXT** choice? **Place your answer in the NEXT box of the answer sheet, and proceed to that BLOCK NUMBER for further instructions.**

ACTION:	ANSWER BLOCK
• REPLACE FUEL PUMP	14
• RETURN VEHICLE TO CUSTOMER, NO PROBLEM FOUND	17
• TEST FUEL FLOW FROM FUEL TANK	12

BLOCK NUMBER 16

You have elected to replace the fuel filter. At this point, too much time has been spent on the vehicle. There is nothing wrong with the fuel filter. Remember, exhaust all the easy quick checks before proceeding to the more difficult ones. Using the answer key, follow the block sequence to determine the correct diagnostic path.

BLOCK NUMBER 17

You have elected to return the vehicle to the customer without repair of the concern. At this point, too much time has been spent on the vehicle. The owner will return the vehicle with the same complaint. Using the answer key, follow the block sequence to determine the correct diagnostic path.

DIAGNOSIS EXERCISES

X. VEHICLE CONCERN: POOR VEHICLE PERFORMANCE/DIES ON ACCELERATION

ANSWER SHEET

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NOTE: Enter your answers from left to right! Remember, you might not use all of the answer squares.

SEE ANSWER KEY ON PAGE 133

XI. VEHICLE CONCERN: ENGINE CRANKS BUT WON'T START (FUEL INJECTION)

The following are **ACTIONS** that you may choose to correct the cause of the concern. Remember, choose only one action. Study the choices and once you have determined what you would do first, place your answer in the **first** box of the answer sheet. Then, proceed to that specific **BLOCK NUMBER** for further instructions.

ACTION:

ANSWER BLOCK

- CHECK FOR SPARK FROM IGNITION
- CHECK SPARK PLUGS FOR FOULING
- CHECK CYLINDER COMPRESSION
- PERFORM VISUAL UNDER-HOOD INSPECTION

1
2
3
4

BLOCK NUMBER 1

A check of the ignition spark reveals acceptable spark which is observed from the ignition coil and spark plug wire. Of the **ACTIONS** listed below, which would be your **NEXT** choice? **Place your answer in the NEXT box of the answer sheet, and proceed to that BLOCK NUMBER for further instructions.**

ACTION:

ANSWER BLOCK

- CHECK SPARK PLUGS FOR FOULING
- CHECK FUEL GAUGE
- CHECK CYLINDER COMPRESSION
- TEST IGNITION WITH ENGINE ANALYZER

2
5
3
6

BLOCK NUMBER 2

You have elected to remove the spark plugs and visually inspect for fouling. All of the spark plugs appear to be new. Of the **ACTIONS** listed below, which would be your **NEXT** choice? **Place your answer in the NEXT box of the answer sheet, and proceed to that BLOCK NUMBER for further instructions.**

ACTION:

ANSWER BLOCK

- CHECK FOR SPARK FROM IGNITION
- CHECK CYLINDER COMPRESSION
- PERFORM VISUAL UNDER-HOOD INSPECTION
- TEST IGNITION WITH ENGINE ANALYZER

1
3
4
6

DIAGNOSIS EXERCISES

BLOCK NUMBER 3

A check of the engine compression reveals 120 psi in all cylinders. Of the **ACTIONS** listed below, which would be your **NEXT** choice? **Place your answer in the NEXT box of the answer sheet, and proceed to that BLOCK NUMBER for further instructions.**

ACTION:

- REPLACE FUEL FILTER
- CHECK INERTIA SWITCH
- CHECK FOR SPARK FROM IGNITION
- REPLACE FUEL CHARGING ASSEMBLY

ANSWER BLOCK

8
7
1
9

BLOCK NUMBER 4

A visual inspection under the hood reveals nothing unusual. All connections appear to be secure and tight. Of the **ACTIONS** listed below, which would be your **NEXT** choice? **Place your answer in the NEXT box of the answer sheet, and proceed to that BLOCK NUMBER for further instructions.**

ACTION:

- CHECK FOR SPARK FROM IGNITION
- CHECK FUEL GAUGE
- CHECK SPARK PLUGS FOR FOULING
- CHECK CYLINDER COMPRESSION

ANSWER BLOCK

1
5
2
3

BLOCK NUMBER 5

You have elected to check the fuel gauge on the instrument panel. The gauge indicates a full tank of fuel. Of the **ACTIONS** listed below, which would be your **NEXT** choice? **Place your answer in the NEXT box of the answer sheet, and proceed to that BLOCK NUMBER for further instructions.**

ACTION:

- CHECK INERTIA SWITCH
- REPLACE FUEL PUMP
- REPLACE FUEL FILTER
- PERFORM FUEL SYSTEM TESTS AT FUEL CHARGING ASSEMBLY

ANSWER BLOCK

7
11
8
10

BLOCK NUMBER 6

You have elected to scope check the ignition system. At this point, too much time has been spent on the vehicle. There is nothing wrong with the ignition system: Remember, exhaust all the easy quick checks before proceeding to the more difficult ones. Using the answer key, follow the block sequence to determine the correct diagnostic path.

DIAGNOSIS EXERCISES

BLOCK NUMBER 7

You have elected to verify the operation of the inertia switch. The switch is set properly. Of the **ACTION** listed below, which would be your **NEXT** choice? **Place your answer in the NEXT box of the answer sheet, and proceed to that BLOCK NUMBER for further instructions.**

ACTION:

ANSWER BLOCK

- | | |
|---|----|
| • PERFORM FUEL SYSTEM TESTS AT FUEL CHARGING ASSEMBLY | 10 |
| • REPLACE FUEL FILTER | 8 |
| • REPLACE FUEL CHARGING ASSEMBLY | 9 |
| • PERFORM FUEL DELIVERY TEST AT FUEL PUMP | 12 |

BLOCK NUMBER 8

You have elected to replace the fuel filter. At this point, too much time has been spent on the vehicle. There is nothing wrong with the fuel filter. Remember, exhaust all the easy quick checks before proceeding to the more difficult ones. Using the answer key, follow the block sequence to determine the correct diagnostic path.

BLOCK NUMBER 9

You have elected to replace the fuel charging assembly. At this point, too much time has been spent on the vehicle. There is nothing wrong with the fuel charging assembly. Remember, exhaust all the easy quick checks before proceeding to the more difficult ones. Using the answer key, follow the block sequence to determine the correct diagnostic path.

BLOCK NUMBER 10

You have determined that an evaluation of the fuel delivery system is necessary. A pressure and volume test is performed at the location between the fuel filter and the fuel charging assembly. Pressure and volume are below specifications. Of the **ACTIONS** listed below, which would be your **NEXT** choice? **Place your answer in the NEXT box of the answer sheet, and proceed to that BLOCK NUMBER for further instructions.**

ACTION:

ANSWER BLOCK

- | | |
|-------------------------------------|----|
| • REPLACE FUEL CHARGING ASSEMBLY | 9 |
| • CHECK FUEL FILTER FOR RESTRICTION | 13 |
| • REPLACE FUEL PUMP | 11 |

BLOCK NUMBER 11

You have elected to replace the fuel pump. At this point, too much time has been spent on the vehicle. There is nothing wrong with the fuel pump. Remember, exhaust all the easy quick checks before proceeding to the more difficult ones. Using the answer key, follow the block sequence to determine the correct diagnostic path.

DIAGNOSIS EXERCISES

BLOCK NUMBER 12

You have determined that an evaluation of the fuel delivery system is in order. A pressure and volume test is performed between the fuel filter and fuel pump. Pressure and volume are within specifications. Of the **ACTIONS** listed below, which would be your **NEXT** choice? **Place your answer in the NEXT box of the answer sheet, and proceed to that BLOCK NUMBER for further instructions.**

ACTION:

- CHECK FUEL FILTER FOR RESTRICTION
- REPLACE FUEL PUMP
- REPLACE FUEL CHARGING ASSEMBLY

ANSWER BLOCK

13

11

9

BLOCK NUMBER 13

You have elected to check for a plugged fuel filter. This is the right action to take. The filter is definitely plugged! Now that you have completed this exercise, continue to exercise XII. Vehicle Concern: Starts Normally But Won't Run (Stalls).

DIAGNOSIS EXERCISES

XI. VEHICLE CONCERN: ENGINE CRANKS BUT WON'T START (FUEL INJECTION)

ANSWER SHEET

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NOTE: Enter your answers from left to right! Remember, you might not use all of the answer squares.

SEE ANSWER KEY ON PAGE 133

DIAGNOSIS EXERCISES

XII. VEHICLE CONCERN: STARTS NORMALLY BUT WON'T RUN (STALLS)

The following are **ACTIONS** that you may choose to correct the cause of the concern. Remember, choose only one action. Study the choices and once you have determined what you would do first, place your answer in the **first** box of the answer sheet. Then, proceed to that specific **BLOCK NUMBER** for further instructions.

ACTION:	ANSWER BLOCK
• CHECK AND ADJUST IGNITION TIMING	1
• PERFORM VISUAL UNDER-HOOD INSPECTION	2
• VERIFY PROPER VACUUM ROUTING	3
• PERFORM FUEL SYSTEM PRESSURE AND DELIVERY TESTS	4

BLOCK NUMBER 1

A check of the ignition timing is completed. The timing is within specifications. Of the **ACTIONS** listed below, which would be your **NEXT** choice? **Place your answer in the NEXT box of the answer sheet, and proceed to that BLOCK NUMBER for further instructions.**

ACTION:	ANSWER BLOCK
• CHECK IGNITION ELECTRICAL CONNECTIONS	5
• REPLACE FUEL PUMP	8
• VERIFY PROPER VACUUM ROUTING	3
• CHECK CYLINDER COMPRESSION	6

BLOCK NUMBER 2

You have elected to perform a visual inspection under the hood. All components appear to be connected and routed properly. Of the **ACTIONS** listed below, which would be your **NEXT** choice? **Place your answer in the NEXT box of the answer sheet, and proceed to that BLOCK NUMBER for further instructions.**

ACTION:	ANSWER BLOCK
• CHECK AND ADJUST IGNITION TIMING	1
• CHECK IGNITION ELECTRICAL CONNECTIONS	5
• REPLACE IGNITION MODULE	7
• VERIFY PROPER VACUUM ROUTING	3

DIAGNOSIS EXERCISES

BLOCK NUMBER 3

An inspection reveals proper vacuum hose routing. Of the **ACTIONS** listed below, which would be your **NEXT** choice? Place your answer in the **NEXT** box of the answer sheet, and proceed to that **BLOCK NUMBER** for further instructions.

ACTION:	ANSWER BLOCK
• REPLACE IGNITION MODULE	7
• CHECK CYLINDER COMPRESSION	6
• PERFORM VISUAL UNDER-HOOD INSPECTION	2
• CHECK CAMSHAFT TIMING	12

BLOCK NUMBER 4

You have elected to pressure test the fuel system. This test indicates the fuel system is operating normally. Of the **ACTIONS** listed below, which would be your **NEXT** choice? Place your answer in the **NEXT** box of the answer sheet, and proceed to that **BLOCK NUMBER** for further instructions.

ACTION:	ANSWER BLOCK
• CHECK IGNITION ELECTRICAL CONNECTIONS	5
• REPLACE FUEL CHARGING ASSEMBLY	10
• REPLACE IGNITION MODULE	7
• REPLACE FUEL PUMP	8

BLOCK NUMBER 5

You have elected to verify all ignition electrical connections. All connections are secure and correct. Of the **ACTIONS** listed below, which would be your **NEXT** choice? Place your answer in the **NEXT** box of the answer sheet, and proceed to that **BLOCK NUMBER** for further instructions.

ACTION:	ANSWER BLOCK
• REPLACE FUEL CHARGING ASSEMBLY	10
• CHECK AND ADJUST IGNITION TIMING	1
• DETERMINE IF IGNITION SYSTEM IS CAUSE OF ENGINE STALL-OUT	9
• CHECK CYLINDER COMPRESSION	6

DIAGNOSIS EXERCISES

BLOCK NUMBER 6

You have elected to check the vehicle's cylinder compression. After a wet and dry test the compression is found to be normal. Of the **ACTIONS** listed below, which would be your **NEXT** choice? **Place your answer in the NEXT box of the answer sheet, and proceed to that BLOCK NUMBER for further instructions.**

ACTION:

- CHECK IGNITION ELECTRICAL CONNECTIONS
- REPLACE FUEL CHARGING ASSEMBLY
- REPLACE FUEL PUMP
- DETERMINE IF FUEL SYSTEM IS CAUSE OF ENGINE STALL-OUT

ANSWER BLOCK

5

10

8

11

BLOCK NUMBER 7

You have elected to replace the ignition module. At this point, too much time has been spent on the vehicle. There is nothing wrong with the ignition module. Remember, exhaust all the easy quick checks before proceeding to the more difficult ones. Using the answer key, follow the block sequence to determine the correct diagnostic path.

BLOCK NUMBER 8

You have elected to replace the fuel pump. At this point, too much time has been spent on the vehicle. There is nothing wrong with the fuel pump. Remember, exhaust all the easy quick checks before proceeding to the more difficult ones. Using the answer key, follow the block sequence to determine the correct diagnostic path.

BLOCK NUMBER 9

You have elected to test the ignition system while the vehicle is stalling. This procedure indicates the ignition power is **NOT** lost when the vehicle stalls. Of the **ACTIONS** listed below, which would be your **NEXT** choice? **Place your answer in the NEXT box of the answer sheet, and proceed to that BLOCK NUMBER for further instructions.**

ACTION:

- REPLACE FUEL CHARGING ASSEMBLY
- CHECK CAMSHAFT TIMING
- REPLACE EGR VALVE
- DETERMINE IF FUEL SYSTEM IS CAUSE OF ENGINE STALL-OUT

ANSWER BLOCK

10

12

14

11

BLOCK NUMBER 10

You have elected to replace the fuel charging assembly. At this point, too much time has been spent on the vehicle. There is nothing wrong with the fuel charging assembly. Remember, exhaust all the easy quick checks before proceeding to the more difficult ones. Using the answer key, follow the block sequence to determine the correct diagnostic path.

BLOCK NUMBER 11

You have elected to test the fuel system while the vehicle is stalling. Doing so determines that the fuel system is **NOT** the cause when the vehicle stalls. Of the **ACTIONS** listed below, which would be your **NEXT** choice? **Place your answer in the NEXT box of the answer sheet, and proceed to that BLOCK NUMBER for further instructions.**

ACTION:

ANSWER BLOCK

- | | |
|---------------------------------------|----|
| • DETERMINE IF EGR SYSTEM IS AT FAULT | 13 |
| • CHECK CYLINDER COMPRESSION | 6 |
| • REPLACE EGR VALVE | 14 |
| • CHECK CAMSHAFT TIMING | 12 |

BLOCK NUMBER 12

You have decided to perform a check of the camshaft timing. At this point, too much time has been spent on the vehicle. There is nothing wrong with the camshaft timing. Remember, exhaust all the easy quick checks before proceeding to the more difficult ones. Using the answer key, follow the block sequence to determine the correct diagnostic path.

BLOCK NUMBER 13

You have elected to determine if the EGR valve may be causing the problem. The EGR vacuum line has been disconnected and the engine restarted. The engine now idles. Of the **ACTIONS** listed below, which would be your **NEXT** choice? **Place your answer in the NEXT box of the answer sheet, and proceed to that BLOCK NUMBER for further instructions.**

ACTION:

ANSWER BLOCK

- | | |
|---|----|
| • CHECK EXHAUST FOR EXCESSIVE BACK PRESSURE | 16 |
| • REPLACE EGR VALVE | 14 |
| • CHECK EGR CONTROL SOLENOIDS FOR DAMAGE | 15 |

BLOCK NUMBER 14

You have elected to replace the EGR valve. At this point, too much time has been spent on the vehicle. There is nothing wrong with the EGR valve. Remember, exhaust all the easy quick checks before proceeding to the more difficult ones. Using the answer key, follow the block sequence to determine the correct diagnostic path.

DIAGNOSIS EXERCISES

BLOCK NUMBER 15

You have decided to check the EGR control solenoids. This is the correct diagnosis! The EGR solenoid is stuck in an open position. Now that you have completed this exercise, continue to exercise XIII. Vehicle Concern: Gas Odor.

BLOCK NUMBER 16

You have elected to test the exhaust system for excessive back pressure. At this point, too much time has been spent on the vehicle. There is nothing wrong with the exhaust system. Remember, exhaust all the easy quick checks before proceeding to the more difficult ones. Using the answer key, follow the block sequence to determine the correct diagnostic path.

DIAGNOSIS EXERCISES

XII. VEHICLE CONCERN: STARTS NORMALLY BUT WON'T RUN (STALLS)

ANSWER SHEET

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NOTE: Enter your answers from left to right! Remember, you might not use all of the answer squares.

SEE ANSWER KEY ON PAGE 134

DIAGNOSIS EXERCISES

XIII. VEHICLE CONCERN: GAS ODOR

The following are **ACTIONS** that you may choose to correct the cause of the concern. Remember, choose only one action. Study the choices and once you have determined what you would do first, place your answer in the **first** box of the answer sheet. Then, proceed to that specific **BLOCK NUMBER** for further instructions.

ACTION:

ANSWER BLOCK

- | | |
|--|---|
| • PERFORM VISUAL UNDER-HOOD INSPECTION | 1 |
| • TEST DRIVE VEHICLE | 2 |
| • TALK WITH DRIVER OF VEHICLE | 3 |
| • REPLACE FUEL CHARGING ASSEMBLY | 4 |

BLOCK NUMBER 1

You have elected to perform a visual inspection of the under-hood components. All items related to fuel delivery and return appear to be normal. Of the **ACTIONS** listed below, which would be your **NEXT** choice? Place your answer in the **NEXT** box of the answer sheet, and proceed to that **BLOCK NUMBER** for further instructions.

ACTION:

ANSWER BLOCK

- | | |
|--------------------------------------|---|
| • REPLACE CARBON CANISTER | 6 |
| • REPLACE FUEL CHARGING ASSEMBLY | 4 |
| • VISUALLY INSPECT UNDER THE VEHICLE | 5 |
| • TEST DRIVE VEHICLE | 2 |

BLOCK NUMBER 2

A test drive of the vehicle reveals no gas odor or driveability concern. Everything appears normal. Of the **ACTIONS** listed below, which would be your **NEXT** choice? Place your answer in the **NEXT** box of the answer sheet, and proceed to that **BLOCK NUMBER** for further instructions.

ACTION:

ANSWER BLOCK

- | | |
|--|---|
| • RETURN VEHICLE TO CUSTOMER, NO PROBLEM FOUND | 9 |
| • REPLACE FUEL PUMP | 8 |
| • REPLACE CARBON CANISTER | 6 |
| • REPLACE FUEL CHARGING ASSEMBLY | 4 |

DIAGNOSIS EXERCISES

BLOCK NUMBER 3

You have elected to discuss the concern with the driver of the vehicle to gather more information. He indicates that the odor is detected only when the vehicle is parked in the garage after the fuel tank is filled. The tank has never been overfilled. Of the **ACTIONS** listed below, which would be your **NEXT** choice? **Place your answer in the NEXT box of the answer sheet, and proceed to that BLOCK NUMBER for further instructions.**

ACTION:

ANSWER BLOCK

- | | |
|--|---|
| • PERFORM ANOTHER INSPECTION UNDER THE HOOD AND BODY | 7 |
| • REPLACE CARBON CANISTER | 6 |
| • REPLACE FUEL PUMP | 8 |
| • REPLACE FUEL CHARGING ASSEMBLY | 4 |

BLOCK NUMBER 4

You have elected to replace the fuel charging assembly. At this point, too much time has been spent on the vehicle. There is nothing wrong with the fuel charging assembly. Remember, exhaust all the easy quick checks before proceeding to the more difficult ones. Using the answer key, follow the block sequence to determine the correct diagnostic path.

BLOCK NUMBER 5

You have elected to perform a visual under-body inspection for fuel leaks. Everything appears to be normal. Of the **ACTIONS** listed below, which would be your **NEXT** choice? **Place your answer in the NEXT box of the answer sheet, and proceed to that BLOCK NUMBER for further instructions.**

ACTION:

ANSWER BLOCK

- | | |
|--|----|
| • TIGHTEN ALL FUEL LINE CLAMPS | 10 |
| • REPLACE CARBON CANISTER | 6 |
| • RETURN VEHICLE TO CUSTOMER, NO PROBLEM FOUND | 9 |
| • TALK WITH DRIVER OF VEHICLE | 3 |

BLOCK NUMBER 6

You have elected to replace the carbon canister. At this point, too much time has been spent on the vehicle. There is nothing wrong with the carbon canister. Remember, exhaust all the easy quick checks before proceeding to the more difficult ones. Using the answer key, follow the block sequence to determine the correct diagnostic path.

DIAGNOSIS EXERCISES

BLOCK NUMBER 7

You have elected to recheck under the hood and body for a fuel leak. Again, this reveals nothing. Of the **ACTIONS** listed below, which would be your **NEXT** choice? **Place your answer in the NEXT box of the answer sheet, and proceed to that BLOCK NUMBER for further instructions.**

ACTION:

- REPLACE FUEL TANK
- REPLACE CARBON CANISTER
- REPLACE FUEL CHARGING ASSEMBLY
- CHECK FUEL SYSTEM WITH HC/CO TESTER

ANSWER BLOCK

12
6
4
11

BLOCK NUMBER 8

You have elected to replace the fuel pump. At this point, too much time has been spent on the vehicle. There is nothing wrong with the fuel pump. Remember, exhaust all the easy quick checks before proceeding to the more difficult ones. Using the answer key, follow the block sequence to determine the correct diagnostic path.

BLOCK NUMBER 9

You have elected to return the vehicle to the customer. The next day the vehicle is returned with the same complaint. At this point, too much time has been spent on the vehicle. Using the answer key, follow the block sequence to determine the correct diagnostic path.

BLOCK NUMBER 10

You have elected to tighten all of the fuel line clamps. At this point, too much time has been spent on the vehicle. There is nothing wrong with the fuel line clamps. Remember, exhaust all the easy quick checks before proceeding to the more difficult ones. Using the answer key, follow the block sequence to determine the correct diagnostic path.

BLOCK NUMBER 11

You have elected to use an HC/CO tester to sample the air around the fuel supply and return lines. This is the correct action to take. At the upper part of the fuel tank a vapor line is damaged. This line was not obvious during inspection! You have now completed all of the exercises.

BLOCK NUMBER 12

You have elected to replace the fuel tank. At this point, too much time has been spent on the vehicle. There is nothing wrong with the fuel tank. Remember, exhaust all the easy quick checks before proceeding to the more difficult ones. Using the answer key, follow the block sequence to determine the correct diagnostic path.

XIII. VEHICLE CONCERN: GAS ODOR

ANSWER SHEET

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NOTE: Enter your answers from left to right! Remember, you might not use all of the answer squares.

SEE ANSWER KEY ON PAGE 134

DIAGNOSIS EXERCISES

II. VEHICLE CONCERN: ENGINE IDLES ROUGH/MISFIRES DURING CRUISE

ANSWER KEY

2	1	11							
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III. VEHICLE CONCERN: ENGINE SURGES

ANSWER KEY

2	1	6	11						
---	---	---	----	--	--	--	--	--	--

IV. VEHICLE CONCERN: STALLS OR HESITATES ON ACCELERATION

ANSWER KEY

2	1	4	5	9	12	11			
---	---	---	---	---	----	----	--	--	--

V. VEHICLE CONCERN: CRANKS NORMALLY BUT WON'T START

ANSWER KEY

2	3	7	10						
---	---	---	----	--	--	--	--	--	--

VI. VEHICLE CONCERN: ENGINE NOISE/KNOCKS

ANSWER KEY

3	4	1	2	5	10	14	13		
---	---	---	---	---	----	----	----	--	--

DIAGNOSIS EXERCISES

VII. VEHICLE CONCERN: ENGINE CRANKS BUT WON'T START

ANSWER KEY

1	2	3	5	8	11	12			
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VIII. VEHICLE CONCERN: SPARK KNOCK/PINGING

ANSWER KEY

1	2	3	6	9	13				
---	---	---	---	---	----	--	--	--	--

IX. VEHICLE CONCERN: HESITATES AND STALLS ON ACCELERATION

ANSWER KEY

2	1	5	9	10					
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X. VEHICLE CONCERN: POOR VEHICLE PERFORMANCE/DIES ON ACCELERATION

ANSWER KEY

2	3	5	10	13	15	12			
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XI. VEHICLE CONCERN: ENGINE CRANKS BUT WON'T START (FUEL INJECTED VEHICLE)

ANSWER KEY

4	1	5	7	10	13				
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DIAGNOSIS EXERCISES

XII. VEHICLE CONCERN: STARTS NORMALLY BUT WON'T RUN (STALLS)

ANSWER KEY

2 5 9 11 13 15 8 8 2 1

XIII. VEHICLE CONCERN: GAS ODOR

ANSWER KEY

1 5 3 7 11 8 8 8 2 1



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